DOCUMENT RESUME

ED 218 815		EC 142 754

AUTHOR	Guess, Doug; And Others
TITLE	Quantitative Assessment of Motor and Sensory/Motor Acquisition in Handicapped and Nonhandicapped Infants and Young Children. Volume I: Assessment Procedures for Selected Developmental Milestones.
INSTITUTION	Kansas Univ., Lawrence. Early Childhood Inst.
SPONS AGENCY	Bureau of Education for the Handicapped (DHEW/OE), Washington, D.C.
REPORT NO	ECI-135
PUB DATE	Apr 80
CONTRACT	300-77-0308
NOTE	462p.; For related document, see EC 142 755 and ED 217 668.
AVAILABLE FROM	Kansas University, Early Childhood Institute, Document Reprint Service, Haworth Hall, Lawrence, KS 66045 (no price quoted).
EDRS PRICE	MF01/PC19 Plus Postage.
DESCRIPTORS	Developmental Stages; Early Childhood Education; *Evaluation Methods; Motion; *Motor Development; *Multiple Disabilities; *Perceptual Motor Coordination; *Severe Disabilities; Visual Learning

ABSTRACT

The first of a three volume report on a project to develop and apply quantitative procedures to measure motor and sensory/motor growth in nonhandicapped and severely/multiply handicapped children presents 17 papers delineating ways to measure motor function. The following motoric functions are considered: visual fixation, visual tracking, visual scanning, reach, grasp, release, transfer, head control, sitting behavior, rolling, crawling and creeping, and standing and walking. A review precedes each section and describes measurement instruments and procedures in use for specific skills. (CL)

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QUANTITATIVE ASSESSMENT OF MOTOR AND SENSORY/MOTOR ACQUISITION IN HANDICAPPED AND NONHANDICAPPED INFANTS AND YOUNG CHILDREN

VOLUME I

Assessment Procedures for Selected Developmental Milestones [1]

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ECI Document No. 135

April, 1980

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[1] The material in this volume was supported, in large part, by the Early Childhood Handicapped Institute (USOE 300-77-0308) at The University of Kansas.

NOTE OF CAUTION

The procedures for measuring motor and sensory/motor acquisiton in this volume are based on preliminary investigations with small numbers of handicapped and nonhandicapped infants and children. Most if not all procedures will undergo minor to major changes as additional studies are completed. Accordingly, the authors advise potential users of the procedures that results obtained must be interpreted with caution. The procedures represent only an initial effort towards the development and refinement of a measurement technology for the quantitative assessment of sensory and sensory/motor acquisition.

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INTRODUCTION

The definition of early intervention has shifted in relation to chronological age. Intervention was once considered early if it was initiated with preschool children. The emphasis is now on the development of programs for high-risk infants and children starting as soon after birth as possible and continuing through the preschool years. Haring (1976) estimated that there were 200 to 300 infant programs at the time of his writing. This number is increasing rapidly. Consequently, assessment instruments, checklists, curriculum guides, etc., are now flooding a market that did not exist a few years ago. The application of this proliferation of evaluation strategies and instructional procedures to an established-risk population (i.e., the severely/multiply handicapped) requires thoughtful analysis and careful investigation.

Certainly, successful assessment and intervention with severely/multiply handicapped infants and children may be the most complex technological and social endeavor presently faced by behavioral scientists in special education and human development. There is a national commitment to serve handicapped children in infant and preschool programs. Severely/multiply handicapped children have been assigned high priority. However, the current technology for serving these children lags far behind the commitment to provide services. We have witnessed (and continue to witness) the devastating effects when educational opportunities for severely/multiply handicapped individuals are lacking. Conversely, we do not have adequate empirical data to substantiate the efficiency of current early intervention programs, nor do we have verified technology that can produce positive changes commensurate with our national commitment.

The assessment and educational programs for severely/multiply handicapped (SMH) children are complex because of the gross behavioral deficiencies manifested by these children in combination with impairment to their sensory and motor apparatuses. Accordingly, remediation programs for SMH children must teach skills in small, and logically sequenced increments while also making appropriate adjustments for sensory and motor defects that might significantly impede the learning process. Therefore, any attempt to assess or teach appropriate language, self-help, social interaction, and cognitive development skills must consider that the child may be visually or auditorally impaired, display grossly deficient motor skills, or have additional and complicating health related conditions (e.g., seizures, heart defects).

The assessment instruments and curriculum programs that have recently emerged for the severely/multiply handicapped population do not include a curriculum for severely/multiply handicapped preschool children that is accompanied by documented and convincing positive changes in social, perceptual, motor, behavioral and cognitive development nor are assessment instruments and procedures adequate for recording changes or pinpointing areas for intervention. These observations are not intended as criticisms of existing intervention programs or existing assessment instruments. Many persons (ourselves included) respond to the need for services for the severely/multiply handicapped without sufficient time or resources to validate the program we develop. Unfortunately, the urgency to provide infant and preschool services to severely/multiply handicapped children combined with the absence of validated procedures may reinforce the pessimism that deterred development of these programs in the first place.

One possible problem in the early intervention efforts with severely/multiply handicapped children is that we attempt to accomplish too much with too little information or the wrong type of information. Too little information is reflected by the lack of sensitive assessment procedures and instruments to accurately pinpoint areas for intervention and measure the growth and development of severely/multiply handicapped infants and young children.

Mira (1977) has addressed the problem of assessing and collecting the wrong type of information by pointing out that most assessment strategies have focused on at-risk infants where the primary concern has been the evaluation of cognitive constancy and the prediction of eventual cognitive functioning. Therefore, pre - and post-test scores or scores on global intelligence tests have been used without focusing attention on the processes involved or the course of development. Mira further points out that for the severely/multiply handicapped, we are, as Tjossem (1973) states, dealing with "established risk" infants.

> For these infants the intervention goal is not to produce normal children but to help them function at the top of the range determined by the disability. For these infants the program must center on those gross and fine motor skills culminating in purposeful use of the hands, postural control and ambulation. For these goals an evaluation methodology relying on cognitive function is not useful (p. 32).

Haring (1976) has also addressed the issue of early intervention programs for severely handicapped infants. His arguments closely correspond to the position of Mira that indicates that much of our present information gathering procedures are not relevant because we need intervention efforts that recognize the extent of damage to the central nervous system.

> When educators talk about infant intervention programs, they do not mean those essentially 'compensatory' programs in which a baby from a culturally disadvantaged environment is bombarded with 'enrichment' stimuli. Nor do they mean those infant programs that are merely extensions downward of day care programs offering primarily custodial or babysitting services. Rather, they are talking about programs that are conceptually far more complex and ambitious as they seek to remediate--or help the infant to overcome the effects of--insults far more sweeping than mere cultural deficit: prenatal, perinatal, and postnatal assaults on the central nervous system (p. 26).

Both Mira (1977) directly and Haring (1976) indirectly recognize that early intervention efforts for severely/multiply handicapped infants and young children must concentrate on information that will help identify deficiencies and developing basic motor skills.

The evolution of a number of child developmental assessment scales over the last four decades (e.g., The Gesell Developmental Scale, the Bayley, . . . etc.) has led to a tremendous expansion in the data base on normal child motor development. Several authors (Kral, 1972; Cromwell, 1963; Stein, 1964) have reviewed the general findings resulting from this expanding data base. However, these reviews have not touched on the normative motor development of handicapped children under the age of six, although this is a critical period in any child's motor development.

Surprisingly, the normative data on the motor development of handicapped children six years and younger, encompasses only a handful of studies. In one such study, Kravitz and Boehm (1971) compared the emergence of rhythmic habit patterns (e.g., hand sucking, lip biting, body rocking, etc.) in normal, cerebral palsied, and Down's Syndrome infants and found marked delays in the onset of rhythmic patterns in the two groups of handicapped infants. Using the Gesell Developmental Scales, Dicks-Mireaux (1972) compared the motor development of Down's Syndrome to normal children ranging in age from 28 to 78 weeks. She found the Down's Syndrome children to be significantly retarded in their motor development compared to the normal children as early as 16 weeks of age.

In a descriptive study, Freedman and Cannady (1971) detailed the delayed emergence of prone locomotion in seven developmentally delayed children. Adelson and Frailberg (1974) compared the performance of 10 blind infants (who were otherwise normal) to normal infants on several standard assessments of gross motor development and found significant delays in self-initiated mobility and locomotion. In a study of 70 cerebral palsied infants and preschool children, Banham (1976) found that all the children, regardless of the exact nature of their cerebral palsy, were significantly delayed in their general motor development.

The sparse normative motor development data on young handicapped children suggest that delays and deficiencies in motor development may begin in infancy and continue to affect the child as he/she matures. However, this lack of normative data seriously limits the type of conclusions to be made concerning the influence of motor acquisition (or the lack thereof) on the subsequent progress of the child in related areas (i.e., social, language, and cognitive development).

Any purposeful educational program for this population of infants and children must be predicated on basic and functional motor and perceptual/motor response repertoires. What is not so obvious is that the current technology for teaching these critical motor and perceptual/motor skills is almost as poorly developed as our current technology for precisely and accurately measuring the acquisition of motor and perceptual/motor skills in severely/multiply handicapped infants and children.

Qualitative Measurement of Motor Development in Infants and Young Children

This discussion of a representative sample of the more widely utilized assessment instruments specifically addresses the rationale for the sequencing of items and the limitations of the instruments for yielding specific quantitative data on the process of motor development in a severely/multiply handicapped individual. The focus on motor behavior was chosen as a key area because this population has a high incidence of moderate to severe motor impairment. In addition, basic or rudimentory motor skills are often prerequisites for skills in related areas of development, i.e., personal-social, communication, etc. For example, head and trunk control sufficient for independent sitting combined with coordinated movements in the upper extremities increases the probability of developing self-help skills. Adequate respiratory capacity combined with the ability to coordinate movements of the lips, tongue, and jaw necessary for feeding increases the probability of developing articulation and phonation skills.

The sample of non-standardized assessment instruments selected for discussion include the following: Learning Accomplishment Profile (Sanford, 1975), the Marshalltown Project (Kiesler, Donohue, Montomery, Roecker, & Smith, 1974), Portage Project Checklist (Shearer, Billingsley, Frohman, Hilliard, Johnson, & Shearer, 1972), Developmental pinpoints (Cohen, Gross, & Haring, 1976) and Minimum Objective System for Pupils with Severe Handicaps (Williams & Fox, Note 1). Each of these instruments follows a normal motor development model.

A sequence is inherent in the majority of these instruments (i.e., the mastery of certain skills are necessary for the development of future skills). This sequence as it relates to the motor area is primarily Gesell's (Gesell, Thompson, and Armatruda, 1934). The sequence and rate of development proposed by Gesell, et al. (1934) and later expanded through the work of Bayley (1933), Cattell (1940), and Frankenburg and Dodds (1969) provide the basis for the delineation of the early motor skills in the various instruments mentioned above. In addition, a cumulative effect is observed, i.e., the more recently published works now include the forerunners in this field as references. Haring and Cohen (1975) in a review of curricula for severely/profoundly handicapped persons site the following rationale for the developmental approach:

1. The developmental approach serves as a uniform basis for arranging experiences at least for the first 72 months of development. We believe that once a child has reached a developmental age of 72 months, he can no longer be considered severely handicapped.

> 2. The developmental approach is based upon an observed record of many children from many cultures developing from birth to early childhood; therefore, arranged experiences and interventions on the basis of the sequence typically followed by developing children have a certain logic.
>
> 3. The developmental approach serves as the basis for treatment by several other management disciplines, such as child development specialists, communication disorders specialists, nurses, occupational therapists, and pediatricians. This, of course, increases communication among the disciplines and provides a common basis among disciplines for measuring the child's progress (p. 44).

There is little variability noted in the number and type of motor development items in the majority of the assessments but the format or mode of presentation may vary. The Portage Project (Shearer et al., 1972) Learning Accomplishment Profile (Sanford, 1975), and Marshalltown Project (Keisler et al., 1974) present a hierarchy of developmental skills, drawn from normative data, as the basis for an evaluation of the child's existing skills. Fine and gross motor skills are combined under one motor heading in the Portage Project and are presented sequentially by years, i.e., 0-1, 1-2, etc. Fine and gross motor skills are considered separately in the Learning Accomplishment Profile and are sequenced by months with behaviors listed for one month of age, two months and so on throughout the first year followed by larger increments as chronological age progresses.

The Minimum Objective System for Pupils with Severe Handicaps (Williams & Fox, Note 1) sequences selected classes of behaviors such as sitting, standing and walking on the basis of normal development to decrease the difficulty in tracking one behavior or class of behaviors through the sequence when assessing a pupil and developing a training program. Similarily, the Developmental Pinpoints

(Cohen et al., 1976) is designed to provide information concerning major developmental areas, and on the pattern of development of discrete skills. As the term "pinpoint" refers to a measurable behavior, the emphasis throughout the listing is on that which is observable (Cohen et al., 1976). Developmental Pinpoints adapts the developmental skills listed in existing scales and arranges them in a format which tracks each skill over time rather than following the chronological appearance of skill clusters. Pinpoints are arranged in two general categories: eye readiness and movements involving hands. Gross Motor pinpoints are arranged in general categories: static balance, dynamic balance within basic movement patterns, and coordinated movements.

Mira (1977) observes that these sequential checklists of motor development pinpoints represent the starting point from which to develop a tracking system for the multiply handicapped infant; they provide suggestions for the small behavioral steps that are necessary. They are not sufficient as a monitoring system, however, since they were designed to provide information on the skills that existed prior to intervention, and to identify the appropriate starting point for intervention. Checklist comparisons do not provide information about rate of acquisition and how the emergence of one skill is influenced by the acquisition of other behaviors. Roberts, Bundy, Mira, and Cairns (1978) note that while scales based on the presence/absence strategy yield information about the average age of onset of a behavior and the relative developmental status of an individual infant within his age group, they do not yield complete sequential information about the development of particular response classes.

In several articles and chapters Horowitz (1965; 1968; 1969; and 1976) has also discussed the possibility that developmental outcome may partially depend on how successfully the infant's behavior elicits environmental stimulation and how successful contingent environmental stimulation is in providing reinforcers for the infant's behavior. The checklists, assessments and accompanying curricula rarely address environmental adaptations that may facilitate a partial or total response to the developmental item by the infant/child with a moderate to severe neuromotor disability. Strict adherence to a developmental model may impede progress toward skill acquisition in a population whose movement patterns are so atypical. Extraneous movement (chorea, athetosis, ballesmus) may be inadvertently reinforced in a fine motor program that does not consider positioning of the child or placement of the stimulus object. Clinical experience with infants and young children demonstrating severe neuro-motor disabilities has suggested the effectiveness of alternative sequence for the development and refinement of reach-touch, reach-grasp responses.

The adaptations involved in developing the sequence were based on the premise that reach-grasp-release patterns are critical skills (i.e., prerequisites) to a number of more complex, coordinated skills that cross areas of development. This in conjunction with an understanding of the effects certain primitive reflex patterns impose on the posture of the child yielded a sequence of steps that facilitated the emergence of these responses. Once the skill is acquired, a developmental model provides a framework for further refinement.

Alteration or adaptation of a developmental sequence assumes a firm background in normal child development and the neurophysiological responses that are precursors of the major milestones. The intent is to utilize available sources to identify motor behaviors or pinpoints critical to the acquisition of skills across areas of development rather than to define a new sequence or to devise still another checklist. Equally important is the maintenance over time of quantitative data on individual children to develop a base of information regarding the course of development in the severely/multiply handicapped.

Quantitative Measurement of Motor Development in Infants and Young Children

Given the limitations of traditional assessment instruments and scales for measuring acquisition of motor skills by infants and young children, some investigators have directed their attention toward the development of more precise and sensitive quantitative measurement procedures.

For instance, Edwards and Edwards (Note 2; Note 3), have argued for a system to record dynamic developmental changes that distinguish the target behavior from other behaviors and charting the rate of occurrence. According to Edwards and Edwards (Note 1):

> These two dimensions of behavior development provide a basis for the longitudinal assessment of the development of a single child as well as the isolation of differences in the level of development between 1) an individual child and others his age, 2) children at different age levels, and 3) normal and handicapped children either of the same or different ages (p. 3).

Methods described by Edwards and Edwards (Note 2; Note 3) have included longitudinal measures of both the rate and duration of identified behavior observed in natural settings (usually free play settings in the child's home). In one study (Note 2) Edwards and Edwards used these longitudinal observation procedures to record the development of motor, social, play, and language skills among eleven normal children ranging in age from three to fifty-nine months. Specific motor skills observed and recorded were sit, hold, stand, free stand, creep, hold steps, free steps, pick up object, and place object in mouth. Other behaviors recorded included smile, laugh, look at person, cry, whine, babble, and word use. The longitudinal records were sensitive to the emergence and development of new behavior, the decay of early forms of behavior, typical rate levels of behavior, and across age comparisons.

In a subsequent study, Edwards and Edwards (Note 3) used the same longitudinal rate recording procedures to study the motor, social, play, and language development of four normal and two moderately handicapped children (ages 12 and 15 months). Results of the study indicated the recording and charting procedures were sensitive to acceleration of some behavior as a function of using a walker, and the temporary deceleration of some behavior as a result of illness.

In another study involving continuous measurement over time, Roberts et al. (1978) reported the use of an event recorder to measure changes in frequency and duration of three motor responses in two infants. Chin lifting, chest lifting, and movement to a hand or knee position were recorded when the infants were placed in a prone position. Results showed similar patterns of development between the two infants as well as the behavioral changes across the three motor responses observed. Interestingly, the relationship between response frequency and duration were not consistent across behaviors. There was an inverse relationship between the two measures for chest lifting, following an initial period of positive covariance. According to the authors, "The significant practical applications of this strategy derive from its sensitivity to behavior change in infancy and its ability to detect changes in the course of development at the time that these changes are occurring" (p. 13). The authors also pointed out that diminishing accelerations of emerging behavior may indicate developmental disabilities or the adverse effects of damaging environmental conditions.

Applications of Quantifiable Measurement Procedures to the Severely/Multiply Handicapped

Longitudinal, quantitative measures of motor and sensory/motor development among severely and multiply handicapped infants and young children are necessary for early intervention efforts. Haring (1976) noted that methods to assess "fine focus" behaviors are needed so that tiny lags in development can be treated immediately. Yet, there are few published reports of results or efforts to utilize precision measurement techniques with the motor and perceptual/motor development of severely and multiply handicapped children.

Mira (1977) described a project that utilized a fine grained analysis to measure intervention programs with multi-handicapped infants. The developmental goals for intervention programs with seven infants included postural control, body mobility, and functional hand use. Mira reported that the records obtained included very sensitive measures of child change allowing therapists to quickly assess the effectiveness of the treatment programs and to evaluate the child's current health status. Mira concluded:

> Continuously monitored behavioral development expressed as frequency of occurrence of targeted skills is a very promising basis for therapeutic decision making in the early intervention with multi-handicapped children. It is thus a tactic as well for demonstrating program effectiveness, and therefore, has value in meeting the requirements of program accountability" (p. 36).

Haring (1976) has also described initial efforts to develop a "fine focus" sequence for the infant program at the University of Washington. Specifically, the problem of sitting measured by tracing a silhouette of the infant on a marked grid, thus allowing precision measurement of the angle of the infant's neck and the relative roundness of the back. This graphic visual display allowed the therapist to prescribe week-by-week exercises.

In summary, although the initial attempts to develop quantifiable and continuous measurement procedures for assessing the motor acquisition of severely and multiply handicapped infants are very promising they are, at present, far too limited. Certainly the preliminary studies by Edwards and Edwards (Note 2, Note 3) with normal and moderate handicapped infants are central to the development of this technology. Equally important is the more recent work by Mira (1977) and her colleagues at the University of Kansas Medical Center, that has extended the measurement system to infants with multiple handicaps. Although, it is surprising that more systematic attempts to develop and analyze the fine grain motor and perceptual/motor behavior of handicapped infant and children have not been done, this may reflect the relatively recent interest in providing services to the severely/multiply handicapped child, the even more recent emphasis on early childhood education with this population of children, and the traditional preoccupation with designing and developing "checklist" types of measurement devices.

DESCRIPTION AND SCOPE OF THE QUANTITATIVE SENSORY/MOTOR ASSESSMENT PROJECT

The project to be described at The University of Kansas is directed towards the development and eventual application of quantitative procedures to measure motor and sensory/motor growth in nonhandicapped and handicapped (especially severely/multiply handicapped) infants and young children. For purposes of organization, work scope, and long term planning, the project has been divided into three major but highly interrelated components. Volume I, the essential content of this manuscript, pertains to the identification of critical motor and sensory motor skills and the development of quantitative procedures to measure these skills. Volume II includes studies that measure the reliability of these procedures, and studies that replicate the original procedures with new subject populations. Much of the research reported in Volume II is actually performed in conjunction with the development of the measurement procedures for the identified motor and sensory/motor skills. Our purposes for reporting these reliability and replication studies separately is to help maintain Volume I as primarily a procedures manual and to provide in Volume II a common base for including additional studies as they become available--studies that likely, in turn, will point to revisions in the original measurement procedures. It is important to note at this point that procedures for measuring the various skill areas in Volume I are numbered separately in notebook form. This will allow for revisions to be made within the separate skill areas independent of other areas and thus avoid the complete renumbering of all the pages in the Volume. A similar page numbering system is also used in Volume II, thus allowing new studies to be added to the separate skill area sections as they become available.

In brief summary then, Volume I contains descriptions of quantitative procedures to measure motor and sensory/motor growth, including relevant reviews of the literature for each identified skill area. Volume II includes studies related to the reliability of those procedures and investigations that have replicated the procedures.

A third volume (Volume III), and probably the most important, includes studies and investigations that show how the quantitative measurement procedures can be used in important areas of application. These include, potentially: 1) early detection of a handicapping condition; 2) a method of evaluating early intervention efforts; and, 3) a basis for curriculum development in the motor and sensory/motor area.

These studies involve, longitudinal measurement of infants and young children (handicapped and nonhandicapped) using the simultaneous application of the procedures for the identified motor and sensory/motor skill areas (Volume I). From these data we hope to determine, 1) typical or average acquisition patterns; and, 2) the extent to which various skills covary during acquisition.

Determining typical acquisition patterns of motor and sensory/motor skills using the more sensitive, quantitative measurement procedures has the obvious potential for the early detection of a handicapping condition. Additionally, the identification of typical acquisition patterns has the potential for pinpointing areas in need of remediation. The measurement procedures can then provide a sensitive method of assessing the effectiveness of the intervention effort--an area that is especially needed for severely/multiply handicapped children.

The second outcome of these longitudinal studies (i.e, measuring covariations in skill development) has important implications for a more global curriculum development effort. If the quantitative measurement procedures show, for example, that certain skills are likely to emerge at the same time there exists the potential for grouping skills together as response classes in a sensory/motor curriculum. This is an advantage that present curriculum developers do not have since available evaluation instruments and developmental checklists are too gross to identify potential covariations in sensory/motor acquisition.

Development of Quantitative Procedures to Measure Sensory/Motor Acquisition

Selecting Behavior to Measure

The initial task in developing the system was the identification and selection of "critical" sensory/motor behaviors that are normally acquired during the first 18 months of life, with special attention given to identifying those skills that emerge during the first year. Critical skills were identified as those sensory/motor behaviors that were commonly observed in the majority of developmental sequences and which have obvious importance to the child's overall adaptive behavior. A major source for the identification and selection of the skills was the publication by Cohen, et al. (1976). These authors compiled an extensive list of sensory/motor skills by expected age of occurrence from a large number of standardized and nonstandardized developmental scales and checklists. As such, these skills might well be considered as important "developmental pinpoints" (Cohen, et al. 1976).

The list of sensory/motor "developmental pinpoints" selected for measurement are listed as follows under their major sensory/motor categories.

Visual Orientation: fixation, tracking, and scanning (vertical and horizontal);

Fine Motor: reach, grasp, release, and transfer (objects);

Gross Motor; Stability: head erect and sitting.

Gross Motor; Mobility: rolling, crawling, creeping, and walking.

Each of the above listed sensory/motor skills does represent, however, a fairly gross description of behavior. This was most apparent when initial attempts were made to identify the various skills in relation to the expected age of onset. Discrepancies in the various developmental scales and checklists (to be elaborated on in later sections) pointed to the fact that more quantitative and specific descriptions of these sensory/motor skills are needed for a fine-focus analysis. Importantly, this fine-focus analysis can only be accomplished when more quantitative measurement procedures are developed and validated. This is, of course, the purpose of this project.

Quantitative Procedures for Measuring the Selected Sensory/Motor Skills

Three major phases were followed in developing the quantitative procedures for measuring the sensory/motor skills identified in the preceding section. Phase I consisted of an in-depth literature review of studies, investigations, and existing instruments and developmental checklists that were related to the assessment of each developmental milestone (e.g., visual fixation, reach, grasp, head erect, walking). Phase II was a compilation of subcomponent skills related to each major developmental milestone that could be measured in quantitative terms, and an approximation of the various age levels (months) in which these subcomponent skills were normally expected to occur. Phase III consisted of the development of quantitative procedures to measure the acquisition and emergence of these skills.

Phase I: Reviews of the literature: Literature reviews for each of the major skill areas (developmental milestones) followed a similar format. First, a review was made of existing standardized scales or developmental checklists that included descriptions of the skill area. Attention was given to descriptions of the behavior, the measurement techniques used to score the behavior, equipment used in the assessment, positioning of the child during the assessment, the recommended settings for the observations, and other pertinent information that was either idiosyncratic to a particular instrument or common across the instruments. Similar reviews, obtaining essentially the same information were also conducted for nonstandardized measurement instruments and developmental checklists. Third, each review included a description of more basic research studies and investigations that related to assessing the particular skill area. These studies pertained variously, to the development of measurement procedures, collection of normative data using existing scales and instruments, and, in some cases, experimental manipulation of variables related to the acqisition of the skill.

The purposes of these reviews were twofold. First, it was important to identify any techniques or procedures that have already been designed to measure, quantitatively, the particular sensory/motor skill under investigation. Secondly, the reviews were important in establishing preliminary hierarchies of discrete skills that should be measured in the possible developmental sequence for each area. In other words, normative data from the available literature provided guidelines for Phase II.

Phase II: Identifying Sub-component Skill Hierarchies. Each major skill area was broken down into small units for purposes of quantitative measurement. This was necessary because each "developmental milestone" actually contained many subcomponents that varied according to the position of the child (e.g., prone, supine, sitting), various positions of the arms, legs, trunk, and head, and other types of body alignments and conditions that directly or indirectly effected how and when the behaviors should be measured. "Head erect" behavior, for example, can be measured in the sitting or prone positions, or when the child is pulled from the supine to sitting position. In each of these instances, other areas of the body are important to the skill, and various head and trunk alignments must be considered for the type of measurement procedure used. In other words, "head erect" as a developmental milestone is a complex multi-faceted behavioral entity. The quantitative measurement of this skill requires that behavior be broken down into smaller and more objectively defined units. Phase II of the process consisted, therefore, of identifying and selecting these smaller behavioral units and arranging them in a hierarchy that approximated the age level in which they usually appeared in normal development. In most cases, it was necessary to "average" the age of onset of these subcomponents from the available normative data.

The end result of Phase II was a guideline or "developmental map" for each skill area that listed subcomponent skills in a hierarchy that represented (in chronological age) the best estimate from the information currently available. Additionally, these subcomponent hierarchies included only those behaviors that could be quantified and measured.

Phase III: Selecting and Developing the Quantitative Measurement Procedures. This final phase of the process was directed towards developing specific quantitative measurement procedures for each of the subcomponent units in the behavioral hierarchies described in Phase II. In devising the measurement procedures it was necessary that the procedures be described in sufficient detail that other persons could use them in educational and clinical treatment settings. It was also necessary to devise measurement procedures that did not require sophisticated or expensive equipment and apparatuses. The procedures were designed for practical application by persons with adequate backgrounds in applied behavior analysis and who understood commonly used recording techniques (e.g., frequency and duration measures). To assist in obtaining some continuity across the measurement procedures for the various sensory/motor skills areas, a list of specifications was compiled. These specifications were used as standard guidelines in designing the measurement procedures and the conditions under which the behaviors were to be observed. These specifications were listed as follows:

Description of Behavior(s): This included a clear and observable definition of the behavior to be measured. The following definition of "head erect" measured in the prone position serves as an example: "The head is considered to be in the erect position when no part of the head or neck (chin to clavicle) is touching the supporting surface, nor resting on or touching the child's arms which are in contact with the supporting surface."

Conditions for Observation. Explicit descriptions were presented of the conditions under which the measures were taken. These included such considerations as: the position of the child at the start of the observation period; a detailed explanation, if necessary, of how the child was to be moved or handled during the observation period; and, any variations in the conditions that were desired when observing a child across different settings.

Observation Settings. This required explanations of the various settings in which the observations were to be made. These ranged from structured settings where the child was manipulated for purposes of taking data to nonstructured settings where the behavior was allowed to occur spontaneously. In each case, specific details were provided on how the particular environment was to be arranged, including the location of materials, equipment, observers, etc.

Materials and Equipment. Descriptions were provided of any specific materials or special apparatus used in the measurement procedures. These descriptions included dimensions as well as methods of construction. Where appropriate, diagrams of the apparatus or special equipment were provided.

Data Recording Procedures. This required identification of the particular procedure(s) used to measure the specified behavior, including the time limits of the observation period, the recording system used (e.g., frequency, duration, interval) and copies of the data sheets. In some instances the procedures required multiple observations of behavior, e.g., recording arm positions simultaneous with measures of head erect.

Interobserver Reliability. The procedures clearly indicated the conditions for taking interobserver (and intraobserver) measures of reliabilities. The types of reliability measures to be taken were specified as well as the frequency of the measures. Also included were instructions as to whether the measures were to be taken from direct observation of the child, from videotapes, or both. All of these specifications were, of course, essential to the reliability and replication studies reported in Volume II of this project.

The remainder of this volume is now devoted to a presentation of the literature reviews, identified subcomponent hierarchies and measurement procedures for the selected sensory/motor skill areas.

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Review of Measurement Instruments and Procedures for Assessing Visual Behaviors: Implications for Quantitative Measurement

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(ECI Document No. 118)

March 1979

Preparation of this paper was partially supported by a grant from the Bureau for the Education of the Handicapped (USOE 300-77-0308).

The purpose of this review is to examine the assessment of vision as it relates to and interacts with motor development. Therefore, the focus is on eye readiness skills that normally occur in the first few months of life and generally precede eventual eye-hand coordination. For the purpose of this review these visual skills fall into three general categories: fixation, tracking, and scanning. Fixation skills involve focusing of the eyes on a specific object or stimulus array. These skills develop sequentially beginning with momentary regard, progressing through prolonged regard and alternating regard until the child is able to reliably fixate on small objects (Gesell, 1928; Griffiths, 1954; and Bayley, 1969). Tracking skills involve movement of the eyes. These skills include the ability to move the eyes horizontally, vertically, and in a circle until the child is able to visually explore the environment (Cattel, 1940; Griffiths, 1954; and Bayley, 1969). Scanning skills involve the process by which a child explores and acquires information from the visual environment (Day, 1975). As standardized tests, nonstandardized assessments, and basic research are reviewed, visual fixation, tracking, and scanning skills will be considered in relation to general measurement techniques, response definitions, testing conditions, and stimulus descriptions.

Standardized Developmental Scales

The standardized scales reviewed included Gesell's Developmental Schedules (Gesell, 1928 and Gesell and Thompson, 1938), Bayley Scales of Infant Development (Bayley, 1969), The Denver Developmental Screening Test (Frankenburg, Dodds, Fandal, Kozuk and Cohrs, 1975), The Cattell Infant Intelligence Tests (Cattell, 1940), The Griffiths Mental Development Scale (Griffiths, 1954), and Buhler's Test of the First Year of Life

(Buhler, 1930). The scales were developed from the normative data collected on children ranging in age from birth to age six. The variables controlled for in most cases were: sex, race, residence, and education of the head of the household. The scales usually included one or more of the following reliability coefficients: split half, test-retest, and tester-observer.

Perhaps the most widely used base for assessing the development of visual skills in infants has been derived from the normative data and theories of Arnold Gesell (Gesell, 1928 and Gesell and Thompson, 1938). Although specific descriptions of physical responses are lacking in these sources, comprehensive descriptions of the testing conditions are provided. Specifically, the child is tested in the supine position and a dangling ring is used to test both fixation and tracking responses. The ring is held about ten inches above the lower end of the child's sternum. To evoke regard of the stimulus, the ring may be moved left or right into the child's line of vision or bobbed up and down slowly. After a fixation response occurs, horizontal tracking is elicited by moving the ring slowly in an arc at the rate of five seconds per 180°. To assess vertical tracking the ring is moved from eye level to six inches above the head and then down to the infant's toes.

In the Bayley Scales of Infant Developmnt (Bayley, 1969), Nancy Bayley provides descriptions of acceptable responses as well as measurement techniques, testing conditions, and stimuli to be used. For testing on the Bayley items relating to eye movements, the infant is placed either in the supine position or sitting position. The tests are given with the mother present and if it is felt that the mother may be better able to elicit the required behavior, she is asked to present the item. Stimuli used for testing fixation and tracking are a red dangling ring, a human face, a light, a moving person, a pencil, a one-inch cube, and a pellet. Initially the stimulus is placed eight inches from the child's eyes. After movement of the eyes becomes coordinated, the distance is then increased to 12-15 inches. To assess fixation, the stimulus is presented both in the direct line of vision and outside the line of vision so that the child is required to turn to look. For tracking, the child is tested for the ability to track from midline out, and then from a point in the periphery toward the child's center of vision. Movement of the stimulus should take approximately three to four seconds for each foot of distance. Horizontal and vertical movements of the stimulus should be made several times to give the child several opportunities to track. For circular tracking, the stimulus should be moved in a circle about 12 inches in diameter. To be considered circular tracking, the child must follow the stimulus in both upper and lower halves, although not necessarily continuously. Several seconds between shakes are allowed to give the child the opportunity to move his eyes from one to another.

On the Denver Developmental Screening Test (Frankenburg, Dodds, Fandal, Kozuk, and Cohrs, 1975) visual items are found in the Personal-Social and Fine Motor-Adaptive sections. Brief definitions of acceptable responses and general descriptions of conditions are both included. The child is placed in the supine position for all items up until five months, when the visual activities start to become coordinated with hand movements. The child is then held sitting on a parent's lap at a table so that the hands can be placed on a table. Stimuli used in testing include a face, a piece of red yarn, and a raisin. For regard of a face, the stimuli should be held within 12 inches of the child. A piece of red yarn is held six inches from the child's eyes for testing tracking and a raisin is placed on a table to test regard. The examiner may shake the yarn or point to the raisin to attract the child's attention. Tracking includes following to the midline position, past midline, and then in a 180° arc. The child may either track with the eyes alone or with the head and eyes together.

The Cattell Infant Intelligence Tests (Cattell, 1940) include descriptions of stimulus items and general procedures in addition to brief criteria for passing an item. To test regard a one-inch red cube is placed on a table while the child is held sitting in an upright position. A four-inch red ring dangling on a string held about eight inches from the child's eyes is used for tracking while the child is placed in the supine position. The stimulus should be moved at about five seconds per 180° arc and tracking should be continuous throughout the arc. A one and a half inch diameter red ball rolled across a table is also used to test tracking.

The Griffiths Mental Development Scale (Griffiths, 1954) makes considerations for the special needs of handicapped as well as of non-handicapped children in the test situation. Descriptions of testing procedures include the stimuli used, conditions, and general measurement techniques. The child may be lying in the supine position or held by the mother in a reclining position. A small colored ball that rattles is used to attract the attention of the young baby before giving items to test visual skills. Other stimuli used for testing fixation and tracking are a brightly colored ring with attached cord, a ring with attached bells, and a light. Stimuli are held approximately 15-18 inches from the child at right angles to the field of vision. Movement is from center outward and back to center for both vertical and horizontal tracking. Circular tracking should follow a path of about 12 inches in diameter. One item to test scanning is included, in which the infant is required to glance at one object then another. Stimuli used for this item are a ring and a rolling ball. Griffiths notes that too many visual tests should not be taken in succession since it can be very fatiguing to the child.

In The First Year of Life Charlotte Buhler (1930) briefly described testing procedures and acceptable responses for her test. The child is tested in the supine position using a shiny object (she used a wooden disc three and one half inches in diameter covered with tin foil) or the examiner's face positioned at about 12 inches from the child's face as stimuli. On one of the items a light held six inches from the child's face is used to test regard. To assess tracking, the stimulus is first presented in the child's field of vision, moved to one side then to the other and back to center.

NonStardardized Assessment

Several nonstandardized assessment instruments and checklists for use with normal and/or handicapped children list the developmental sequences and ages at which certain skills emerge. These include: Pennsylvania Training Model Assessment (Somerton and Myers, 1976), Behavioral Characteristics Progression (Santa Cruz, 1973), Infant

Learning Program (Gentry, Note 3), Portage Guide to Early Education (Bluma, Shearer, Frohman, and Hilliard, 1976), Memphis Comprehensive Developmental Scale (Quick, Little, and Campbell, 1974), The Callier-Azusa Scale (Stillman, 1975), Behavioral Development Profile (Donahue, Montgomery, Keiser, Roecker, and Smith, 1975), and Developmental Pinpoints, (Cohen, Gross, and Haring, 1976). None of these assessments offer clear definitions of responses to be measured, descriptions of measurement techniques, specification of testing conditions or stimuli to be used. The Koontz Child Development Program (Koontz, 1974) and the Learning Accomplishment Profile (Sanford, 1975) provide lists of visual behaviors and the months at which they emerge along with a general description of measurement techniques and definitions of acceptable responses.

Scheuerman, Baumgart, Sipsma, and Brown (Note 4) in Volume VI of Madison's Alternative for Zero Exclusion provided several general considerations for assessment of visual skills of severely handicapped students. In terms of materials, such factors as size, color, pattern, and complexity were mentioned as important. The authors stated that large objects (one to six inches in diameter or width) may facilitate fixation and brightly colored objects may facilitate initial attending. Furthermore, complex patterns and complex structure (e.g., moving parts) may help attract and maintain attending. The authors suggested that persons as well as objects should be used as stimuli. Multi-sense strategies may be employed while initially attempting to verify visual skill development. This includes, for example, using objects that provide auditory as well as visual input. However, this additional sensory input must be eliminated at some point to accurately assess the child's use of the visual mode to perform the skill. The use of objects or persons for which the student has a demonstrated preference could be used initially, but other objects should also be employed to insure accurate assessment of visual skills.

Scheuerman et al. (Note 4) also provide descriptions of procedures and recommended criterion performance for verification of fixation and pre-tracking skills. In assessing both fixation and tracking, at least two different objects should be presented at eye level in the midline position from within both a short distance (four to eight inches) and a long distance (eight to twelve inches) from the student. Criterion performance for fixation includes alignment of head and at least one eye with the object for a duration of at least one second within five seconds of the presentation. After fixation occurs, tracking should begin within five seconds with both head and the eyes following the object through the desired arc.

Basic Research in Vision

Considerable research has been conducted in the area of vision in infants. Research on basic visual capactities of infants, stimulus-response dimensions, and measurement apparatuses or techniques has important implications for the assessment of visual fixation and tracking.

Research on the basic capacities of infants has shown that the newborn does not easily accommodate (Haynes, White, and Held, 1965), has an average focal distance of 19 centimeters (Haynes et al., 1965), and has some convergence of both eyes on nonmoving objects (Wickelgren, 1967). Lewis, Maurer, and Kay (1978) found that newborns fixate centrally as well as peripherally. The shortness of the eyeball in infants results in a tendency toward farsightedness in about 74 percent of newborns (Spears and Hohle, 1967). By four months of age, the infant has the ability to focus at varying distances in a manner equal to normal adults (Spears and Hohle, 1967). Tracking by this time is smooth and efficient (Ling, 1942) and the capacity for binocular vision has improved (Brown, 1961). Ling (1942) studied the development of fixation and found that sustained visual fixation is absent at birth, begins to appear in rudimentary form a few hours later, and peaks at four to five weeks. Eye movements of fixation develop in four stages that include monocular fixation, monocular dominance, alternation of dominance, and finally binocular fixation by about seven weeks. Illingsworth (1970) stated that the eyes of the newborn tend to move independently with binocular vision beginning at six weeks and being fairly well established by four months.

Numerous studies have been reported that investigated various dimensions of visual stimuli and their effect on responding.

Light. Jones (1926) observed the response of infants to movements of a small flashlight presented at a distance of one foot in a lighted room. The eyes turn slowly toward the light at birth; horizontal, vertical, and rotary pursuit movements were first noted at two weeks, five weeks, and nine weeks respectively. Hershenson (1964) found that the newborn prefers lights of moderate brightness and by three to four months the infant responds to lights of much weaker intensities, indicating a lowering of brightness threshold (Doris and Cooper, 1966).

Color. The photic system is functioning at birth (Barnet, Lodge, and Armington, 1965) and several studies suggest that the newborn can probably discriminate colors (cf. Kessen, Haith, and Salapatek, 1970, for a review). Spears (1964) found that the colors of red and blue are preferred over gray in young infants.

Movement. By two months the infant prefers moving over stationary stimuli (Ames and Silfen, Note 1) and by three months anticipates a regular pattern of movement (Nelson, 1968). Kagan and Lewis (1965) found no difference in preference among six month old infants for a single blinking light, a light moving horizontally, and a light moving in a square helix. However, Cohen (1969) did find a preference for lights blinking in four to sixteen positions over the stationary blinking light. Berkson (1966) has studied eye fixation responses to moving and stationary stimuli in profoundly retarded children. He found that response to the onset of movement was greater than response to offset and the probability of eye fixations on the moving stimulus was maximum immediately after it was presented. Eye fixations declined as a function of the length of time the stimulus was presented.

Response to face. The newborn prefers to look at a regular face over a scrambled face (Fantz, 1961). In infants as young as two weeks, Carpenter (1974) observed longer fixation responses for faces moving in a horizontal motion versus faces that were stationary. Infants under the age of three to five weeks fixate facial areas 21% of the time and then concentrate on areas of high contrast, whereas the seven week and older infant fixates on facial areas over 90% of the time (Bergman, Haith, and Mann, Note 2). Fantz (1967) found longer visual fixation to two dots in the eye position of a circle than to two dots in random positions.

Complexity. Fantz (1965) found that the newborn looks more at patterned than nonpatterned stimuli and Hershenson (1964) found a preference for 2 x 2 checkerboards over more complex (12 x 12) checkerboards. However, Friedman, Nagy, and Carpenter (1970) were not able to replicate this finding. Brennan, Ames, and Moore (1966) and Karmel (1969) showed that infants have a preference for more complex checkerboards with increasing age. However, this result was not found when infants were tested repeatedly over several weeks (Horowitz, Paden, Bhana, Aitchison, and Seif, 1972). According to Karmel (1969) the infant between 13 and 20 weeks prefers stimuli with more contour, however, the complexity dimension did not fit these data. Physiological data (Harter and Suitt, 1970) support the fixation results on contour, indicating this is the stimulus variable responsible for the age shift in preference for smaller checkerboard patterns.

Depth and distance. Fantz (1961) has shown that infants between one and four months prefer three-dimensional over two-dimensional stimuli. McKenzie and Day (1972) found that the distance the object is from the child determines the length of fixation; no further than one meter is best.

Novelty. Studies by Friedman (1972), Saayman, Ames and Moffett (1964), and Steele and Pederson (1977) involving newborns, three month old infants, and six month old infants, respectively, demonstrated that a novel stimulus is explored visually more than a stimulus which is familiar. Switzky, Woolsey-Hill, and Quoss (1979) studied habituation of visual fixation in profoundly retarded children age five to sixteen and also found an increase in visual fixation to the novel stimulus by this population.

After a detailed review of the literature, Day (1975) has identified six developmental trends in the area of scanning. With age, there is

(1) an increased demonstration of a systematic strategy for acquisition of visual information, (2) increased maintenance of a strategy across variations in context and arrangement of stimuli, (3) more focus on aspects of stimuli most informative for a specific task, (4) increased exhaustiveness and efficiency of visual scanning, (5) increased speed of visual scanning, and, (6) an enlarged field of view.

Young and Sheena (1975) have summarized and reviewed various measurement techniques used in studying eye movements. Electrooculography (EOG) measures the position of the eye with skin electrodes placed around the eye. Limbus, pupil, and eyelid tracking involves scanning of the eye with a normal television camera. The most precise measurements of eye movement are made with one of the techniques employing some device tightly attached to the eye with a contact lens. The most common measurement technique is that of corneal reflection, in which the overlap of the reflected stimulus image with the center of the pupil is observed. This method is effective when the stimulus is lighted (Berkson, 1966 and Switzky et. al., 1979), but has also been successful when white stimulus cards are used (Saayman, Ames, and Moffett, 1964).

One of the more advanced eye-movement recording techniques is use of the Lambert oculometer, described by Monty (1975). This device involves television monitoring of the eyes and incorporates the use of a minicomputer for automatic high-speed data processing.

Several studies of visual behavior have reported satisfactory reliabiity (90% and above) in using only direct observation of the infant's eyes and head movements toward a stimulus (Friedman, 1972, Lewis, et. al., 1978, and McKenzie and Day, 1971). Karmel (1969) determined visual attending with the additional observation of the wrinkling of the forehead and eyebrows.

Illingworth (1970) has described several eye reflexes of the infant in reference to normal and abnormal development. Those which may have some bearing on assessment of fixation and tracking are the "doll's eye" response and the "photic sneeze" reflex. The "doll's eye" response, in which the eyes do not normally move with the head, is always present in the first ten days of the newborn. It disappears therafter, as fixation develops, however, the reflex may persist in abnormal babies. The "photic sneeze" reflex consists of a sneeze when a bright light is shown into the eyes.

Hierarchy of Visual Behaviors

In determining a hierarchy of behaviors (see Figure 1) relating to fixation, tracking, and scanning skills it is necessary to refer to the normative data and/or developmental scales of Gesell (1928), Gesell and Thompson (1938), Buhler (1930), Cattell (1940), Griffiths (1954), and Bayley, (1969). All of these scales reflect the same general course of development of visual skills, however, they may ascribe different ages at which the individual behaviors become apparent. In the first month, the infant looks at a stimulus momentarily when in the line of vision and is able to follow a stimulus horizontally past midline (Gesell, 1928; Griffiths, 1954; and, Bayley, 1969). These behaviors do not emerge until the second month on Buhler (1930) and Cattell's (1940) developmental scales. However, according to the data from Bayley (1969), the infant should also display prolonged regard, vertical and circular coordination of the eyes in the first month. During the second month the infant exhibits prolonged regard for a stimulus and is able to track both horizontally and vertically more than 90° (Gesell, 1928; Cattell, 1940; and, Griffiths, 1954). By age two months infants in Bayley's

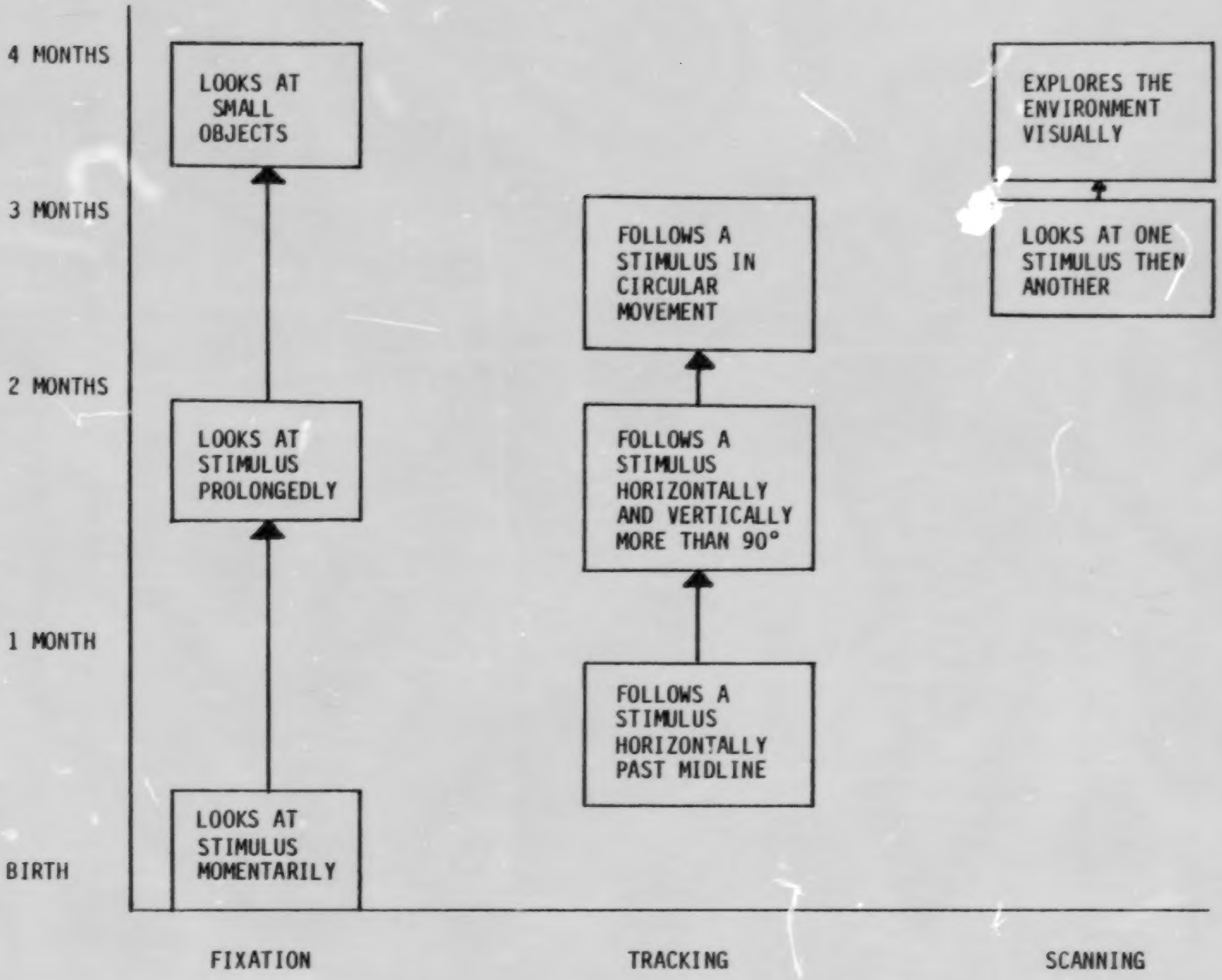
4 MONTHS
3 MONTHS
2 MONTHS
1 MONTH
BIRTH
LOOKS AT SMALL OBJECTS
LOOKS AT STIMULUS PROLONGEDLY
LOOKS AT STIMULUS MOMENTARILY
FOLLOWS A STIMULUS IN CIRCULAR MOVEMENT
FOLLOWS A STIMULUS HORIZONTALLY AND VERTICALLY MORE THAN 90°
FOLLOWS A STIMULUS HORIZONTALLY PAST MIDLINE
EXPLORES THE ENVIRONMENT VISUALLY
LOOKS AT ONE STIMULUS THEN ANOTHER
FIXATION
TRACKING
SCANNING

FIGURE 1: LATTICE FOR EMERGENCE OF VISUAL SKILLS

sample (1969) were looking at one object then another (scanning) as well as fixating on small objects. By the end of the third month the infant should be tracking circular movements and fixating on one stimulus then another (Cattell, 1940, and Griffiths, 1954). The four month old infant explores the environment visually and is able to fixate on small objects (Gesell, 1928; Buhler, 1930; Cattell, 1940; and, Griffiths, 1954). At about four to five months the child's visual behavior begins to be directed toward manipulation of the environment and eye-hand coordination (Gesell, 1928, and Bayley, 1969).

Discrepencies on specific details other than ages for the emergence of skills occur when the different scales are compared. These discrepencies are: (1) the position of the child (either supine or held sitting), (2) stimuli used (which may include lights, persons or faces, and a wide variety of objects encompassing several stimulus dimensions), (3) movement involved (either head and eyes moving together or eyes moving alone), (4) number of degrees of the arc tracked in relation to assigned age of acquisition, and, (5) the distance the child is from the stimulus (anywhere from 8 inches to 18 inches).

From the scales reviewed there are three general areas of visual skills to be measured: fixation, tracking, and scanning. Fixation behavior should be measured in terms of frequency and duration of eye contact to the stimulus, types and size of stimuli, location and distance of the stimulus from the child, and position of the child. Tracking behavior measurements should include distance and path tracked (horizontal, vertical, and circular), types and size of stimuli, distance of the stimulus from the child, position of the child, and the speed of movement of the stimulus. Scanning patterns should be measured in terms of frequency, duration, location, and sequence of fixations, types and sizes of stimuli, and position of the child.

The conclusion which can be drawn after reviewing the literature on the development and measurement of visual skills in infants and young children is that the available procedures are far from satisfactory to meet the needs of classroom teachers. The standardized scales and non-standardized assessments are as a whole too vague in terms of measurement techniques, response definitions, testing conditions, and stimulus descriptions. The techniques used in basic research studies involve expensive and/or technologically intricate equipment which would be beyond the scope of classroom use. What is needed are well defined response definitions of fixation, tracking, and scanning behaviors along with relatively inexpensive and uncomplicated apparatuses for reliably measuring those behaviors.

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VISUAL ORIENTATION

Procedures for Measuring

Visual Fixation

by

Rhonda Eye[1] and Cynthia M. Janssen

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[1] The procedures reported in this study were taken from master's thesis research conducted by Rhonda Eye that was submitted to the Department of Special Education at the University of Kansas in November, 1979.

Measuring Visual Fixation

Procedures for measuring visual fixation are described in this section. These procedures represent an improvement over previous procedures typically utilized for the assessment of visual fixation because of the further specification of response definitions, testing conditions, and measurements obtained.

The assessments traditionally used to measure visual skills have not generally included clear definitions of the behavior to be measured. The procedures in this section include a behavioral description of fixation which avoids ambiguity.

The conditions for measurement are more clearly stated than in other assessments. The positions for placement of the child have been expanded to include prone and sidelying, as well as sitting. Stimulus items are not standard, but rather are determined by whether they are preferred by the child. The distance the stimuli are presented from the child's face is specified as are the number and length of trials. Antecedent and consequent events are also included. The grid, which is used to standardize placement of stimulus items, is unique to the present assessment procedures.

The type of measurement obtained has traditionally been that of occurrence-nonoccurence. With the present procedures, a measure of duration and frequency of visual fixation is obtained.

Visual Fixation in a Sitting Position

Procedures described for this position are designed to measure the frequency and duration of visual fixations when the child is sitting.

Materials and Equipment

Necessary materials for assessment are appropriate data sheets (see Figure 1), pencils, a cumulative stop watch, a 15 second timer, desk or table, and one of the following: chair, wheelchair, adult's lap or floor. An additional apparatus (described below) is required for measuring visual fixation in a sitting position. This apparatus is used in measuring visual fixation in sidelying and prone positions.

Plexiglass grid. The apparatus for measuring visual skills (see Figure 2) is a large square of plexiglass, 3' x 3' that has been attached to a wood base and divided into nine sections with tape. The wood base measures 4" x 4" x 36" and is used to support the grid. The plexiglass is attached to the base with three 2 1/2 inch screws approximately 11 inches apart. Two side supports measuring 3/4" x 4" x 12" are nailed to the ends of the wooden base for additional stability. The nine sections of the grid are marked with quarter inch tape with the center section of the grid measuring 8" x 8". Small holes are drilled in the center of each section 1/2 inch from the top. Hooks are screwed into these holes for use in assessing visual fixation and visual scanning skills.

Preferred items. Reinforcement selection tests (Streifel, 1974) using objects and edibles are administered to each child prior to measuring visual fixations to determine preferential items. These items are used to elicit fixation behaviors and as reinforcers following each trial. At least five preferred items need to be identified for each child.

Observational Settings

Measuring visual fixation in a sitting position can take place in a classroom or in the home. However, it may be necessary to relocate to an isolated area or separate room, depending on the distractability of the child.

Fixation

Student ____________________

Student Birthdate ____________

Date ______________________

Examiner ___________________

Setting ____________________

Start Time _________________

End Time ___________________

Position ___________________

Grid Section Code

A	B	C
D	E	F
G	H	I

TRIAL	STIMULUS	DISTANCE	SECTION	FREQUENCY	TOTAL DURATION	$\bar{X}$ DURATION	COMMENTS

Figure 1: Fixation Data Sheet

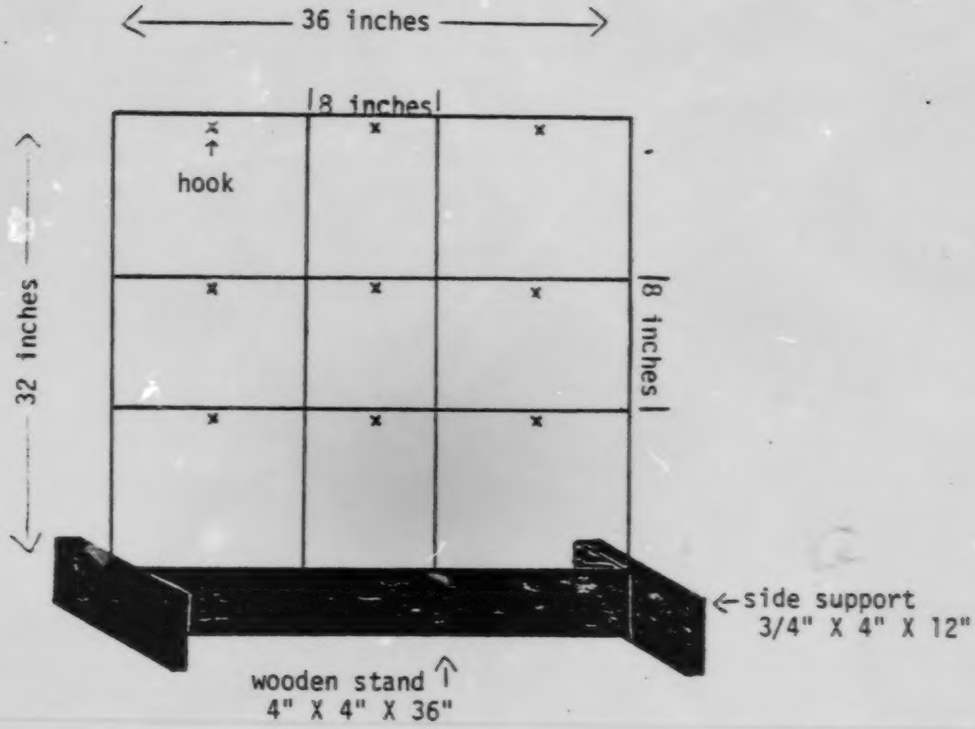

36 inches
8 inches
hook
32 inches
8 inches
side support
3/4" X 4" X 12"
wooden stand
4" X 4" X 36"

Figure 2: Plexiglass Grid

Positioning the Child

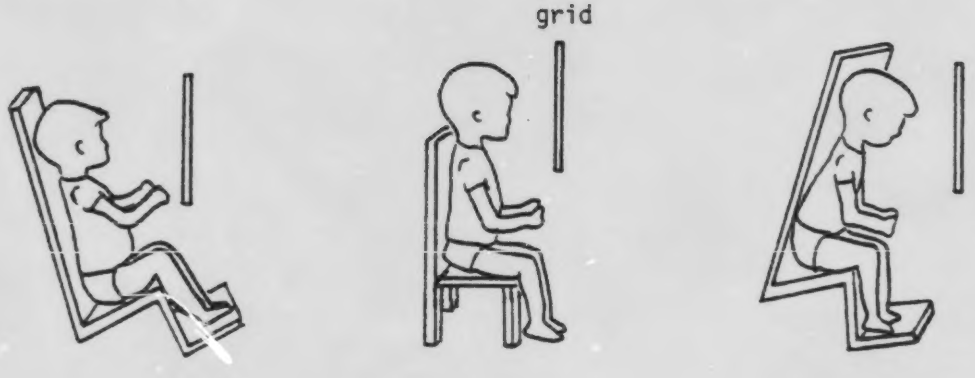
Place the child in a sitting position in a chair, desk, wheelchair, adult's lap or on the floor. The child must be positioned so that the center section of the grid is even with his/her face. The sitting posture may be more reclining or forward than a 90 degree angle, depending on the physical capacity of the child. Various positions of the child are illustrated in Figure 3. Pillows, belts or physical support from an adult may be used if the child is unable to maintain the sitting position independently (Figure 3). When measuring visual skills, a trial is started over if the child loses balance, leans, falls, or moves from the sitting position.

Description of the Behavior

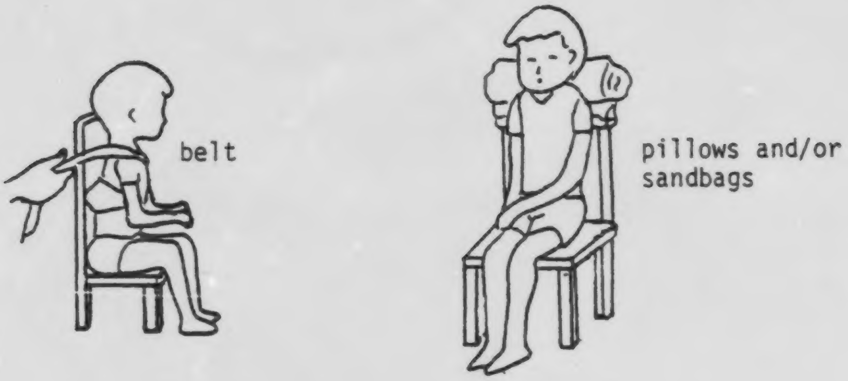
Visual fixation is considered to occur when the child's eyes are directed toward the stimulus presented for a minimum of one second. This definition is also used when measuring visual fixation in the sidelying and prone positions.

Procedures for Measurement

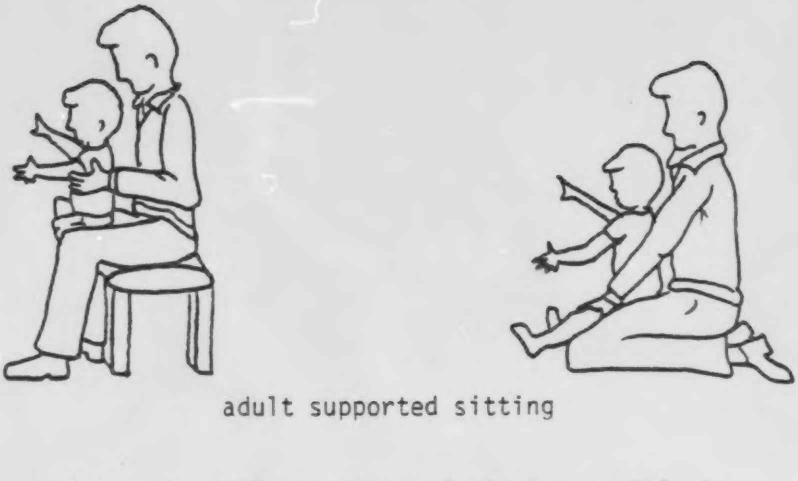
Two different measures are taken, frequency and duration, of visual fixation behavior. Each session consists of 18 trials: one trial for each of the nine sections of the grid when the grid is placed 6-12 inches from the child, and one trial for each section of the grid when the grid is placed 18-24 inches from the child. The duration of each trial is 15 seconds. The section of the grid used for each trial is predetermined by random selection. Each section will be used twice per session. Three stimulus items are used during each session. The item to be displayed in each section is also predetermined by random selection. The length of each session will be approximately 35 minutes.



90° and other sitting angles


belt
pillows and/or
sandbags

supported sitting



adult supported sitting

Figure 3: Illustrations of sitting positions

The procedures for each trial are as follows:

1. The child is positioned as described previously (refer to Positioning the Child).

2. The 15 second timer is activated as a stimulus item is placed on the hook in a section of the grid and the examiner says and/or signs (for a hearing impaired child), "Name, look". To attract the child's attention the object may be moved slightly up and down or left to right while giving the cue. These cues are administered only once per trial. Begin recording fixations after the examiner says and/or signs, "Name, look".

3. Each time the child fixates on the stimulus, a stopwatch is activated for the duration of the fixation and the occurrence is recorded by making a slash mark on the data sheet. Upon completion of each trial the stimulus object may be given to the child for approximately one minute.

4. A cumulative record of duration is recorded for each trial. Frequency, duration, and mean duration are recorded on the data sheet upon completion of each trial. Mean duration for each trial is determined by dividing the total duration of fixations by the frequency of fixations.

Any comments concerning the trial are recorded in the "Comments" column of the data sheet (see Figure 1). Information which might be recorded could include: nystagmus, patch over left eye, or using response of the right eye only.

When more than one session is held in a day, a break should be scheduled between sessions to avoid eye fatigue in the child. It may also be necessary to allow the child to rest between trials and grid distances.

Tabulating and Graphing the Data

Three methods of tabulating data are recommended for visual fixation behavior. These methods are: (1) number of visual fixations per trial;

(2) duration of visual fixations per trial, and (3) mean duration of visual fixations per trial. Mean duration for each trial is found by dividing the total duration by the frequency of fixations.

Visual Fixation in a Sidelying Position

Procedures described for this section are designed to measure the frequency and duration of visual fixations when the child is placed in a sidelying position.

Materials and Equipment

Necessary materials are appropriate data sheets, a cumulative stop watch, a 15 second timer, and an elevated table mat or incline mat. The plexiglass grid and preferential items previously described (Refer to Visual Fixation in a Sitting Position) are also employed.

Observational Setting

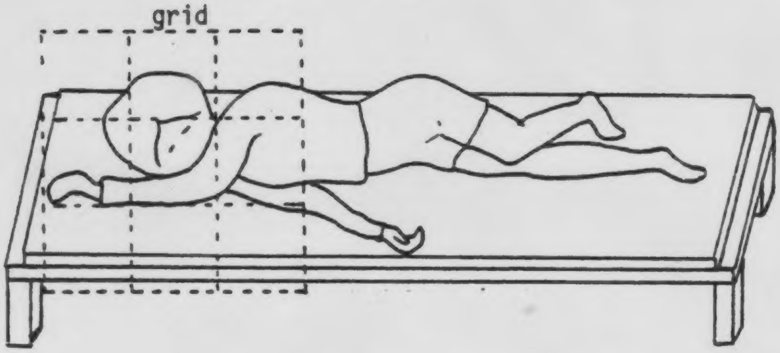
Measuring visual fixation in a sidelying position can take place in a classroom or in the home.

Positioning the Child

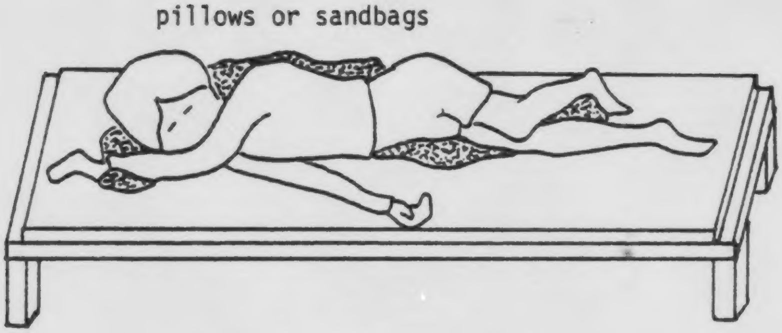
Place the child in a sidelying position on an incline or table mat (see Figure 4). Position the center section of the plexiglass grid even with the child's face. Pillows, sandbags, or physical support from an adult may be used if the child is unable to maintain the sidelying position. Reposition the child and start the trial over if he/she loses balance and rolls forward or backward, or moves from the sidelying position during a trial.

Description of The Behavior

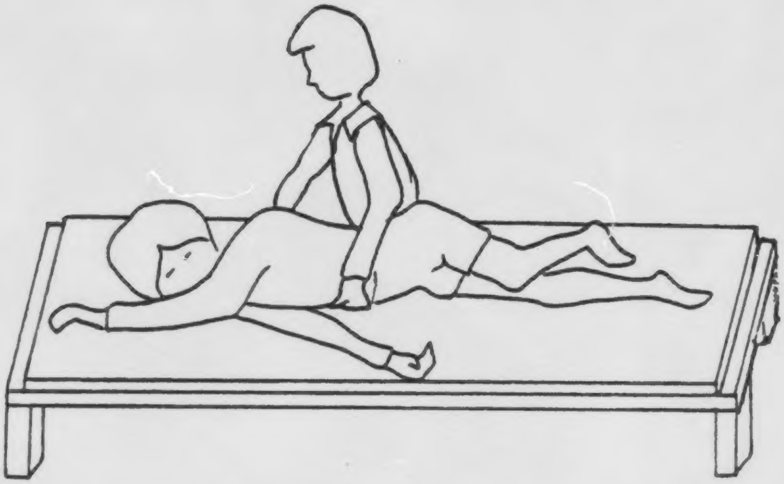
The definition of visual fixation has been previously described (Refer to Visual Fixation in a Sitting Position).



Non-supported side lying position


pillows or sandbags

Supported side lying position



Adult supported side lying position

Figure 4: Illustrations of sidelying positions

Procedures for Measurement

Procedures for measurement of visual fixation have been previously described (Refer to Visual Fixation in Sitting Position).

Tabulating and Graphing the Data

Procedures for tabulating and graphing the data have been previously described (Refer to Visual Fixation in a Sitting Position).

Visual Fixation in a Prone Position

Procedures described for this position are designed to measure the frequency and duration of visual fixations when the child is placed in a prone position.

Materials and Equipment

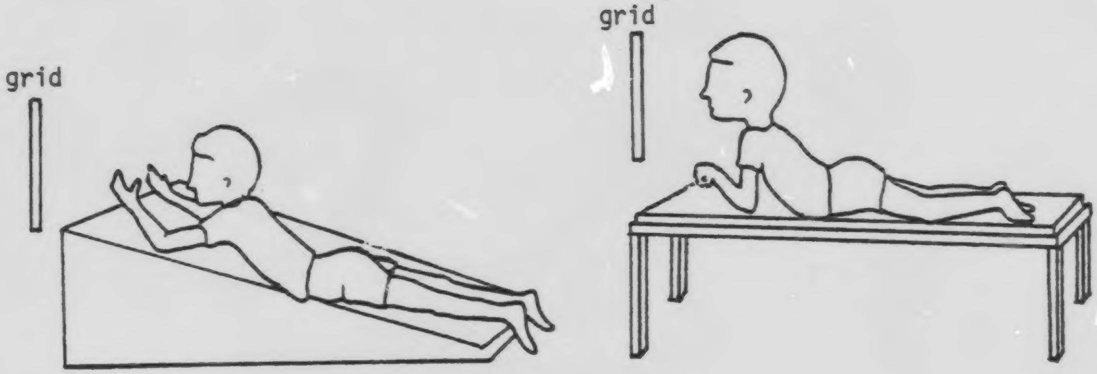
Necessary materials are appropriate data sheets, a cumulative stopwatch, a 15 second timer, and an elevated flat mat, or an incline mat. The plexiglass grid and preferential items previously described (Refer to Visual Fixation in a Sitting Position) are also employed.

Observation Setting

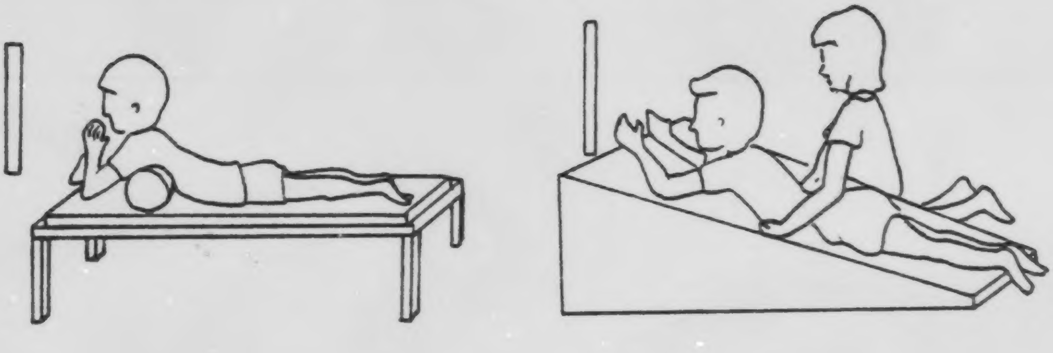
Measuring visual fixation in the prone position can take place in a classroom or in the home.

Positioning the Child

Place the child in the prone position on the mat (see Figure 5). The shoulders and head should be elevated. The child may be able to independently support his/her weight by propping up on flexed elbows. Pillows, sandbags, or support from an adult are used if the child is unable to maintain the position independently. The center section of the grid is positioned even with the child's face. Reposition the child and start the trial over if he/she loses balance or moves from the prone position during the trial.



Non-supported prone positions



Supported prone positions

Figure 5: Illustrations of prone positions

Description of The Behavior

The definition of visual fixation has been previously described (Refer to Visual Fixation in a Sitting Position).

Procedures for Measuremnt

Procedures for measurement of visual fixation have been previously described (Refer to Visual Fixation in a Sitting Position).

Tabulating and Graphing the Data

Procedures for tabulating and graphing the data have been previously described (Refer to Visual Fixation in a Sitting Position).

VISUAL ORIENTATION

Procedures for Measuring

Visual Tracking

by

Beverly Humphrey[1] and Cynthia M. Janssen

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[1] The procedures reported in this study were taken from master's thesis research conducted by Beverly Humphrey that was submitted to the Department of Special Education at the University of Kansas in November, 1979.

Measuring Visual Tracking

Procedures for measuring visual tracking are described in this section. These procedures represent an improvement over previous procedures typically utilized for the assessment of visual tracking because of the further specification of response definitions, testing conditions, and measurements obtained.

The assessments traditionally used to measure visual skills have not generally included clear definitions of the behavior to be measured. The procedures in this section include a behavioral description of tracking which avoids ambiguity.

The conditions for measurement are more clearly stated than in other assessments. The positions for placement of the child have been expanded to include prone and sidelying, as well as sitting. Stimulus items are not standard, but rather are determined by whether they are preferred by the child. The distance the stimuli are presented from the child's face is specified as are the number of trials. Antecedent and consequent events are also included. The grid which is used to standardize placement of stimulus items, is unique to the present assessment procedures.

The type of measurement obtained has traditionally been that of occurrence-nonoccurrence. With the present procedures, a measure of the tracking path is obtained.

Visual Tracking in a Sitting Position

The procedures described are designed to measure the distance the eyes follow an object on a horizontal, vertical, diagonal, and circualr plane when the child is sitting.

Materials and Equipment

Necessary materials for assessment are appropriate data sheets (see Figure 1), pencils, desk or table, and one of the following: chair, wheelchair, adult's lap, or floor. An additional apparatus (described below) is required for measuring visual tracking in a sitting position. This apparatus is also used in measuring visual tracking in sidelying and prone positions.

Plexiglass grid. The apparatus for measuring visual skills (see Figure 2) is a large square of plexiglass, 3' x 3' that has been attached to a wood base and divided into nine sections with tape. The wood base measures 4" x 4" x 36" and is used to support the grid. The plexiglass is attached to the base with three 2 1/2 inch screws approximately 11 inches apart. Two side supports measuring 3/4" x 4" x 12" are nailed to the ends of the wooden base for additional stability. The nine sections of the grid are marked with quarter inch tape with the center section of the grid measuring 8" x 8". Small holes are drilled in the center of each section 1/2" from the top. Hooks are screwed into these holes for use in assessing visual fixation and visual scanning skills.

Preferred items. Reinforcement selection tests (Streifel, 1974) using objects and edibles are administered to each child prior to measuring visual tracking to determine preferential items. These items are used to elicit fixation behaviors and as reinforcers following each trial. At least five preferred items need to be identified for each child.

Observation Setting

Measuring visual tracking in a sitting position can take place in a

Tracking

Student________________________

Student Birthdate________________

Date__________________________

Examiner_______________________

Setting________________________

Start Time________End Time________

Position_______________________

GRID SECTION CODE

A	B	C
D	E	F
G	H	I

TRIAL	STIMULUS	DISTANCE	START SECTION	PATH	PRESENTATIONS					SECTIONS TRACKED	NUMBER TRACKED	COMMENTS
					1	2	3	4	5			
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												

Figure 1: Tracking Data Sheet

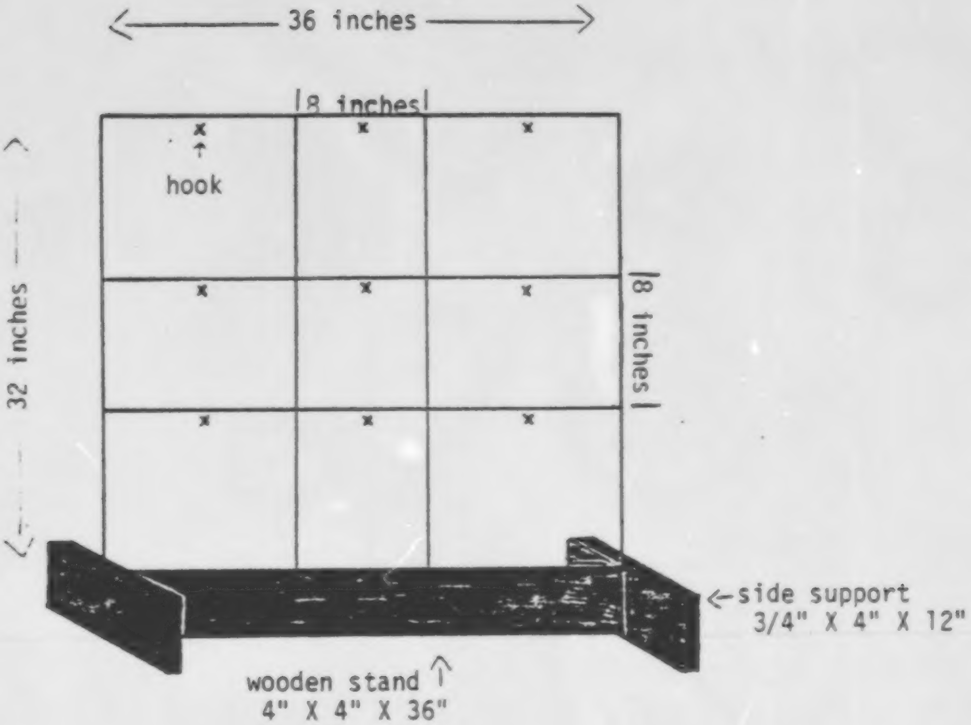

36 inches
8 inches
hook
32 inches
8 inches
←side support
3/4" X 4" X 12"
wooden stand
4" X 4" X 36"

Figure 2: Plexiglass Grid

classroom or in the home. However, it may be necessary to relocate to an isolated area or separate room, depending on the distractibility of the child.

Positioning the Child

Place the child in a sitting position in a chair, desk, wheelchair, adult's lap or on the floor. The child must be positioned so that the center section of the grid is even with his/her face. The sitting posture may be more reclining or forward than a 90 degree angle, depending on the physical capacity of the child. Various positions of the child are illustrated in Figure 3. Pillows, belts, or physical support from an adult may be used if the child is unable to maintain the sitting position independently (Figure 3). A trial is started over if the child loses balance, leans, falls, or moves from the sitting position.

Description of Behaviors

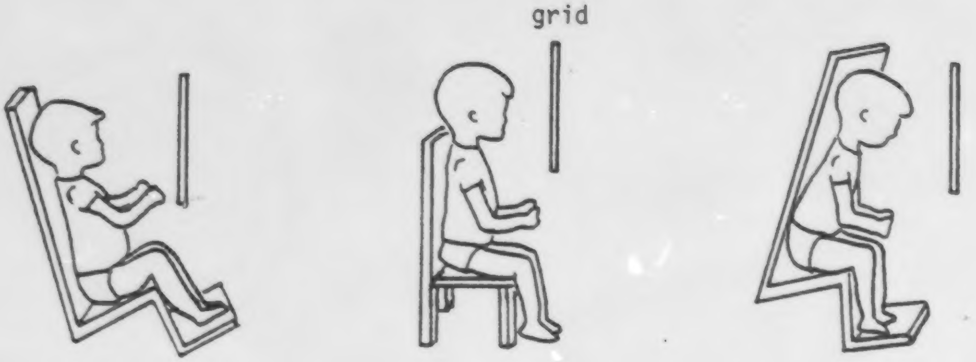
The following definitions are used to describe the various tracking repsonses during the measurement procedure:

Horizontal tracking.

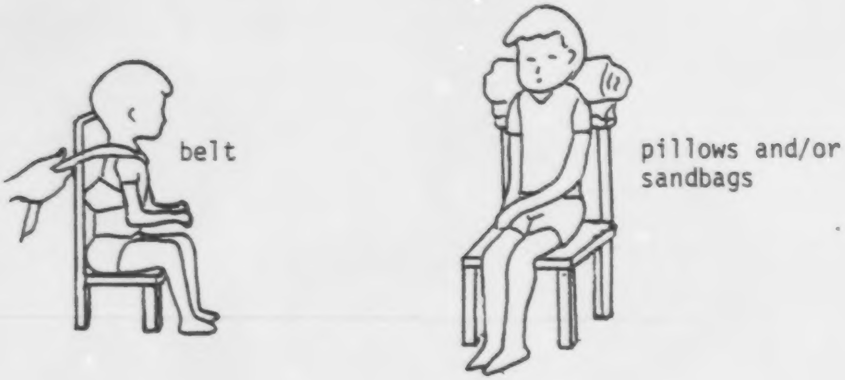
This movement first involves fixating on a stationary object, followed by movement of the eyes that corresponds in topography to movement of the object on a horizontal plane, either from left to right, or from right to left. Fixation is defined as when the child's eyes are directed toward the stimulus presented for a minimum of one second. The cycle begins when the eyes begin to follow the moving stimulus object and ends when eye movement ceases or deviates from the path of the stimulus object.

Vertical tracking.

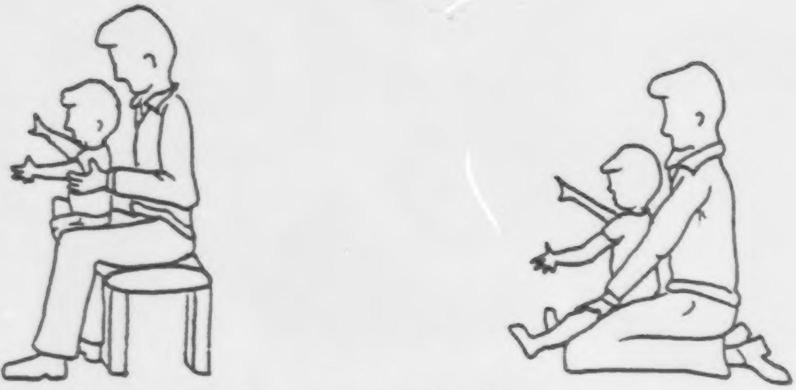
This movement involves fixation on a stationary object, followed by movement of the eyes when tracking the object on a vertical plane. The cycle begins when the eyes begin to follow the



90° and other sitting angles


belt
pillows and/or sandbags

supported sitting



adult supported sitting

Figure 3: Illustrations of sitting positions

moving stimulus object and ends when eye movement ceases or deviates from the path of the stimulus object.

Diagonal tracking. This movement involves fixation on a stationary object, followed by movement of the eyes when tracking an object in a diagonal plane. The cycle begins when the eyes begin to follow a moving object and ends when eye movement ceases or deviates from the path of the stimulus object.

Circular tracking. This movement involves fixation on a stationary object, followed by movement of the eyes that corresponds in topography to movement of the object in a circular pattern. The cycle begins when the eyes begin to follow the moving stimulus object and ends when eye movement ceases or deviates from the path of the stimulus object.

In each of the above definitions, the head does not need to remain in a fixed position. A tracking response may involve head movement as the eyes follow the stimulus object.

Procedures for Measurement

Prior to presentation of any stimulus, the examiner should fill in all the heading information on the data sheet and become familiar with the procedures for recording data. Each session consists of presenting the tracking stimulus in ten different directions that include each tracking pathway in the near distance (6-12 inches) and in ten directions in the far distance (18-24 inches). Before testing, the pathways of the stimulus objects are drawn on the data sheet under "Path" in a randomized order to represent the various paths as seen in Table 1. Each trial is assigned a different pathway, along with a particular section in which the stimulus object is presented; this is labeled under the "Start Section". The student's position and the

TABLE 1

Plane	Path	Section on Grid
Horizontal	→	ABC, DEF, or GHI
Horizontal	←	CBA, FED, or IHG
Vertical	↓	ADG, BEH, or CFI
Vertical	↑	GDA, HEB, or IFC
Diagonal	↘	AEI
Diagonal	↖	IEA
Diagonal	↙	CEG
Diagonal	↗	GEC
Circular	↻	*BCFIHGDA
Circular	↺	*BADGHIFC

*The circular starting position may begin in any of these sections and continue around to complete the circle (360°).

A	B	C
D	E	F
G	H	I

distance at which the grid is placed (near, 6-12 inches; or far, 18-24 inches) should also be premarked. The stimulus items should be varied throughout the session so as to avoid habituation and/or inattentiveness. Thus, they should be marked on the data sheet as they are used for each trial.

The procedures for each trial are as follows:

1. The child is positioned as described previously (refer to Positioning the Child).

2. The trial begins with the verbal cue and/or visual sign (for a hearing impaired child) "(Name), look", at which time the tracking stimulus is presented in the predetermined section of the grid.

3. If fixation occurs within five seconds, begin movement of the stimulus in the designated path. The stimulus object should be moved at the rate of one section per second.

4. If fixation does not occur within five seconds, remove the stimulus and check the first column under presentations.

5. After five seconds from the removal of the stimulus object, represent it in the same section. Mark each presentation in the appropriate column.

6. If fixation does not occur after five presentations, proceed to the next pathway on the data sheet.

7. Following a tracking response or failure to get a fixation response, mark those sections that were tracked with a plus (+) and those not tracked with a minus (-).

8. Continue with the next trial as soon as the data is scored or after reinforcement if it is needed to maintain the child's cooperation with the testing.

In the comments section which is provided for each trial, note observations such as nystagmus, jerky movement with one or both eyes, eye jerks when crossing midline, numerous distractions, etc.

When more than one session is held in a day, a break should be scheduled between sessions to avoid eye fatigue in the child. It may also be necessary to allow the child to rest between trials and grid distances.

Tabulating and Graphing the Data

Data are tabulated by determining the percent of sections tracked for each plane. Add the number of sections tracked (pluses) for each trial and write it in the number tracked column. Group each of the trials according to the plane it represents: horizontal, vertical, diagonal, or circular. For each separate plane, add the total number of sections tracked and divide by the total number of sections the stimulus object passed through. By using one graph to reflect horizontal and vertical tracking and a second graph for diagonal and circular tracking it may be quicker and easier to make comparisons and identify problem areas.

Visual Tracking in the Sidelying Position

The procedures described are designed to measure the distance the eyes follow an object on a horizontal, vertical, diagonal and circular plane when the child is placed in a sidelying position.

Materials and Equipment

Necessary materials are appropriate data sheets and an incline mat or elevated table mat. The plexiglass grid and preferential items previously described (Refer to Visual Tracking in a Sitting Position) are also employed.

Observation Setting

Measuring visual tracking in a sidelying position can take place in a classroom or in the home.

Positioning the Child

Place the child in a sidelying position on a raised table mat or incline mat (see Figure 4). The specific position should depend on what is most comfortable for the child. Provide support as needed to assure positioning the center section of the plexiglass grid even with the child's face. The grid is placed in front of the child at either the near distance or far distance. Each tracking pathway is to be tested for both grid positions. Reposition the child and start the trial over if he/she loses balance and rolls forward or backward, or moves from the sidelying position during a trial.

Description of Behaviors

The definition of visual tracking has previously been described (Refer to *Visual Tracking in a Sitting Position*).

Procedures for Measurement

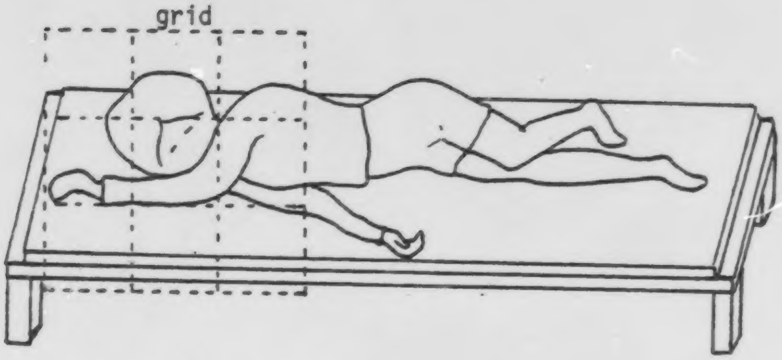
Procedures for measurement of visual tracking have been previously described (Refer to *Visual Tracking in a Sitting Position*).

Tabulating and Graphing the Data

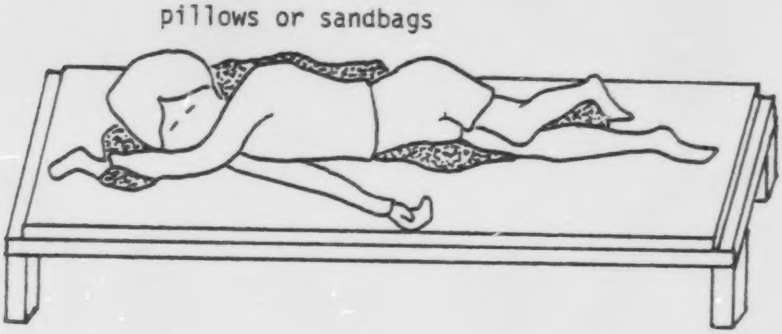
Procedures for tabulating and graphing the data have been previously described (Refer to *Visual Tracking in a Sitting Position*).

Visual Tracking in a Prone Position

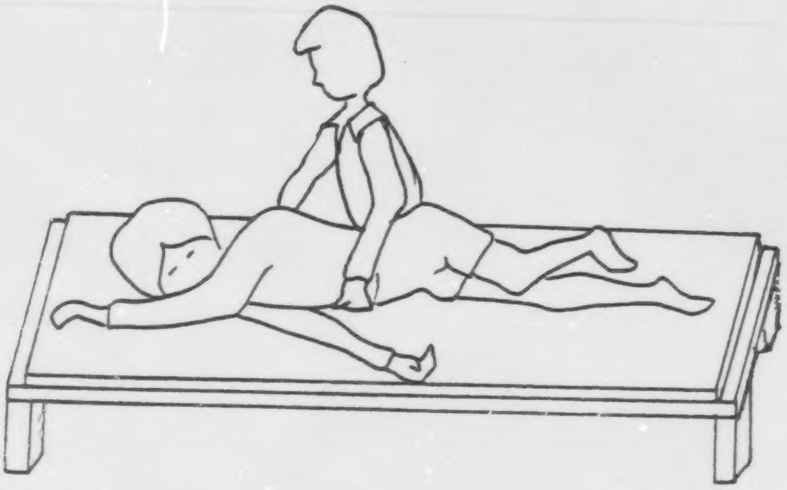
The procedures described are designed to measure the distance the eyes follow an object on a horizontal, vertical, diagonal and circular plane while in a prone position.



Non-supported side lying position


pillows or sandbags

Supported side lying position



Adult supported side lying position

Figure 4: Illustrations of sidelying positions

Materials and Equipment

Necessary materials are appropriate data sheets, an elevated flat mat, or an incline mat. The plexiglass grid and preferential items previously described (Refer to Visual Tracking in a Sitting Position) are also employed.

Observation Setting

Measuring visual tracking in the prone position can take place in a classroom or in the home.

Positioning the Child

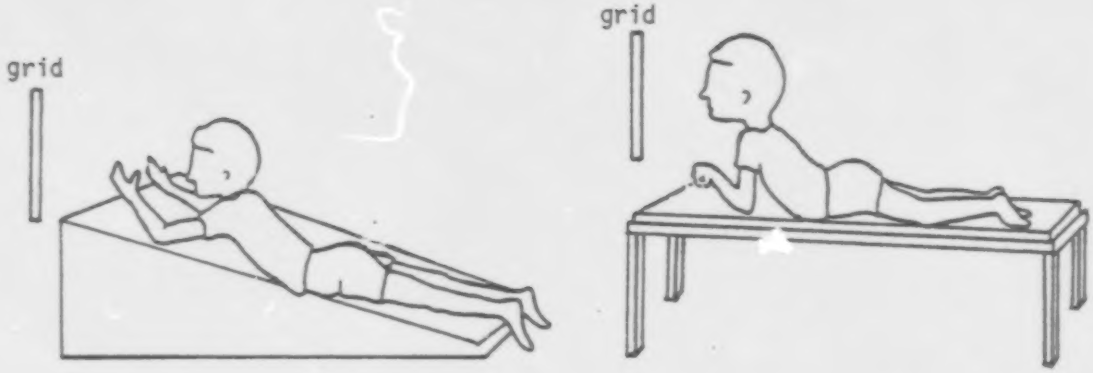
Place the child in the prone position on a raised or incline mat (see Figure 5). The specific position should depend on what is most comfortable for the child. Provide support as necessary to assure positioning the center section of the plexiglass grid even with the child's face. The grid is placed in front of the child at either the near distance (6-12 inches in front of the child) or the far distance (18-24 inches away from the child). Each tracking pathway is to be tested for both positions of the grid. Reposition the child and start the trial over if he/she loses balance or moves from the prone position during the trial.

Description of the Behavior

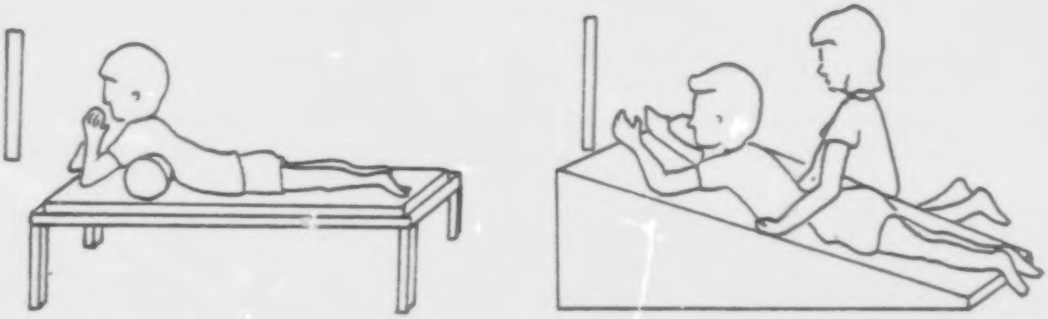
The definition of visual tracking has been previously described (Refer to Visual Tracking in a Sitting Position).

Tabulating and Graphing the Data

Procedures for tabulating and graphing the data have been previously described (Refer to Visual Tracking in a Sitting Position).



Non-supported prone positions



Supported prone positions

Figure 5: Illustrations of prone positions

VISUAL ORIENTATION

Procedures for Measuring

Visual Scanning

by

Leslie Fernandez[1] and Cynthia M. Janssen

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[1] The procedures reported in this study were taken from master's thesis research conducted by Leslie Fernandez that was submitted to the Department of Special Education at the University of Kansas in November, 1979.

Measuring Visual Scanning

Procedures for measuring visual scanning are described in this section. These procedures represent an improvement over previous procedures typically utilized for the assessment of visual scanning because of the further specification of response definitions, testing conditions, and measurements obtained.

The assessments traditionally used to measure visual skills have not generally included clear definitions of the behavior to be measured. The procedures in this section include a behavioral description of scanning which avoids ambiguity.

The conditions for measurement are more clearly stated than in other assessments. The positions for placement of the child have been expanded to include prone and sidelying, as well as sitting. Stimulus items are not standard, but rather are determined by whether they are preferred by the child. The distance the stimuli are presented from the child's face is specified as are the number and length of trials. Antecedent and consequent events are also included. The grid, which is used to standardize placement of stimulus items, is unique to the present assessment procedures.

The type of measurement obtained has traditionally been that of occurrence-nonoccurrence. With the present procedures, a measure of frequency of visual contacts with two or three stimulus objects in the scan path is obtained.

Visual Scanning in a Sitting Position

Procedures described for this postion are designed to measure the frequency and mean frequency of visual contacts with objects in the scan path when the child is sitting. Scan path is defined as the grid sections which the child's eyes visually contact.

Materials and Equipment

Necessary materials for assessment are appropriate data sheets (see Figure 1), pencils, a 15 second timer, desk or table, and one of the following: chair, wheelchair, adult's lap or floor. An additional apparatus (described below) is required for measuring visual scanning in a sitting position. This apparatus is also used in measuring visual scanning in sidelying and prone positions.

Plexiglass grid. The apparatus for measuring visual skills (see Figure 2) is a large square of plexiglass, 3' x 3', that has been attached to a wood base and divided into nine sections with tape. The wood base measures 4" x 4" x 36" and is used to support the grid. The plexiglass is attached to the base with three 2 1/2 inch screws approximately 11 inches apart. Two side supports measuring 3/4" x 4" x 12" are nailed to the ends of the wooden base for additional stability. The nine sections of the grid are marked with quarter inch tape with the center section of the grid measuring 8" x 8". Small holes are drilled in the center of each section 1/2" from the top. Hooks are screwed into these holes for use in assessing visual fixation and visual scanning skills.

Preferred items. Reinforcement selection tests (Streifel, 1974) using objects and edibles are administered to each child prior to measuring visual scanning to determine preferential items. These items are used to elicit fixation behaviors and as reinforcers following each trial. At least five preferred items need to be identified for each child.

Observational Settings

Measuring visual scanning in the sitting position can take place in

Scanning

Student ______________________

Student Birthdate ______________

Date __________________________

Examiner ______________________

Setting _______________________

Start Time ______ End Time ______

Position ______________________

A	B	C
D	E	F
G	H	I

TRIAL	STIMULI/SECTION	DISTANCE	FREQUENCY OF VISUAL CONTACTS			$\overline{X}$ FREQUENCY	COMMENTS
			1	2	3		
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						
	1 2 3						

Figure 1: Scanning Data Sheet

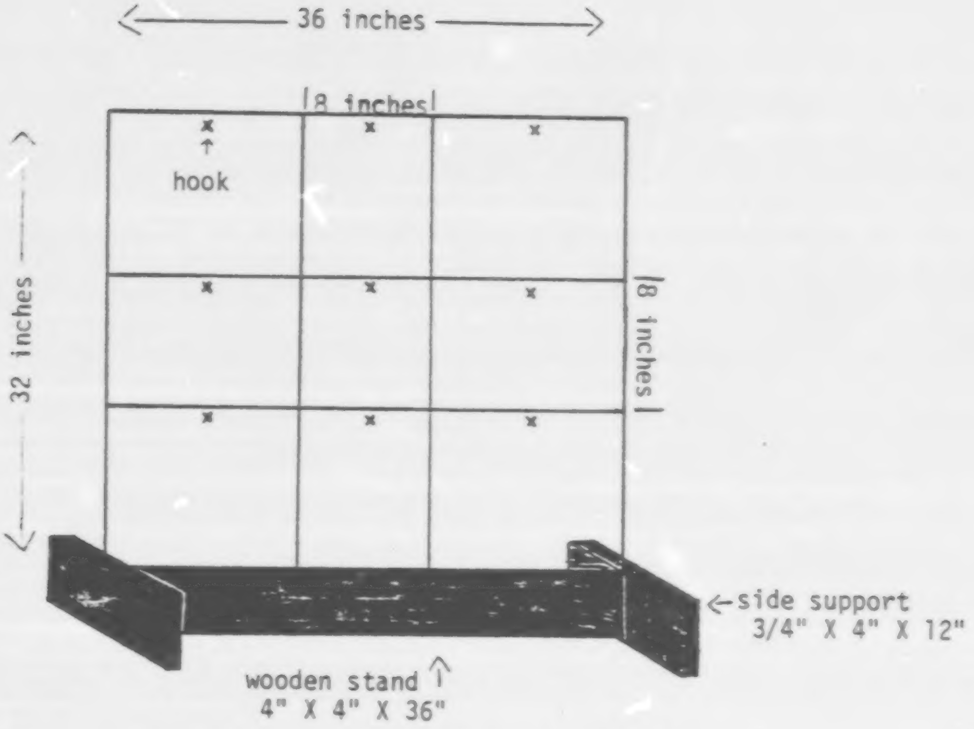

36 inches
8 inches
hook
32 inches
8 inches
side support
3/4" X 4" X 12"
wooden stand
4" X 4" X 36"

Figure 2: Plexiglass Grid

a classroom or in the home. However, it may be necessary to relocate to an isolated area or separate room, depending on the distractibility of the child.

Positioning the Child

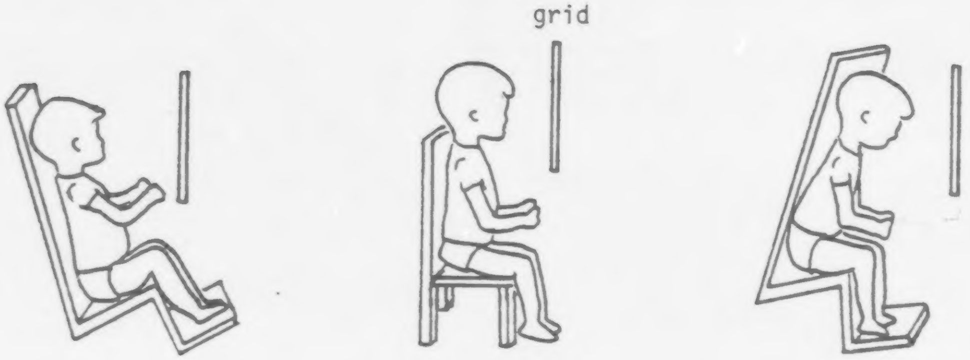
Place the child in a sitting position in a chair, wheelchair, on the floor, on in an adult's lap. The child is positioned so that the grid's center section is even with his/her face. The sitting posture may be more relining or forward than a 90 degree angle, depending on the physical capacity of the child. Various sitting positions and grid placements are illustrated in Figure 3. Pillows, belts, or physical support from an adult may be used if the child is unable to maintain the sitting position independently. The trial is started over if the child loses balance, leans, falls, or moves from the sitting position.

Description of the Behavior

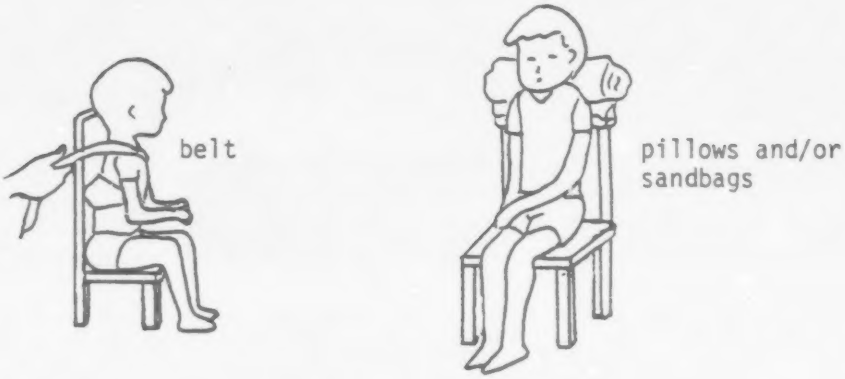
Visual scanning is considered to occur if the child's eyes make visual contact with grid sections in which the stimuli are presented within fifteen seconds of verbal or signed cue. This definition is also used when measuring visual scanning in the sidelying and prone positions.

Procedures for Measurement

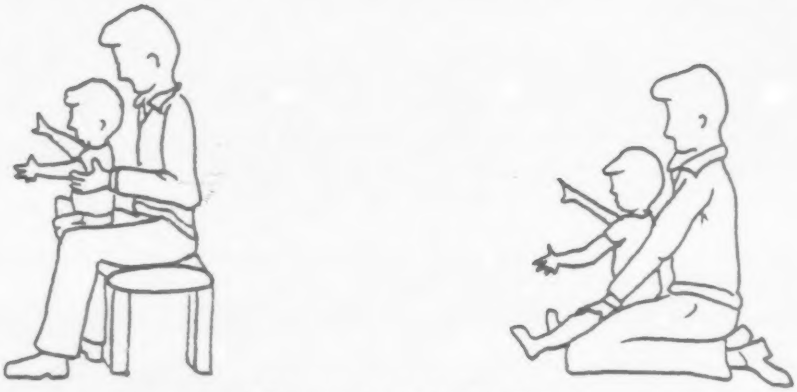
Two different measures are taken of visual scanning behavior: frequency of visual contacts with stimuli, and mean frequency of visual contacts with stimuli. Each session consists of 18 trials: a horizontal trial with two objects, grid 6-12 inches from child; a vertical trial with two objects, grid 6-12 inches from the child; two diagonal (upper right-lower left, lower right-upper left) trials with two objects, grid 6-12 inches from child; a horizontal trial with three objects, grid 6-12 inches



90° and other sitting angles


belt
pillows and/or sandbags

supported sitting



adult supported sitting

Figure 3: Illustrations of sitting positions

from child; two diagonal (upper right-lower left, lower right-upper left) trials with three objects, grid 6-12 inches from child; a random trial with three objects, grid 6-12 inches from child; and nine trials repeating above with the grid 18-24 inches from child (see Figure 4). The positions are determined by random selection and presented in random order. The duration of each trial is fifteen seconds. The stimulus items used during each trial are predetermined by random selection. Edible objects and non-edible objects are not mixed in any one trial.

The procedures for each trial are as follows:

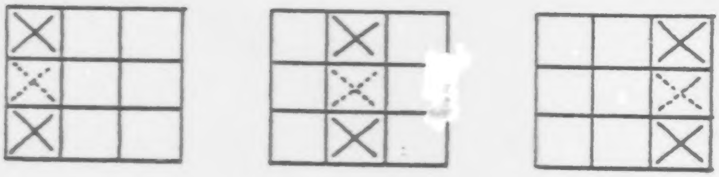
1. The child is positioned as described previously (see _Positioning the Child_). The examiner is positioned directly in front of the child and grid so the examiner may clearly view the child's eyes. The grid is masked, either by a cloth drape or opaque screen, so that the child cannot see the grid.

2. The examiner arranges the stimulus objects on the grid in the predetermined array, hanging them from hooks.

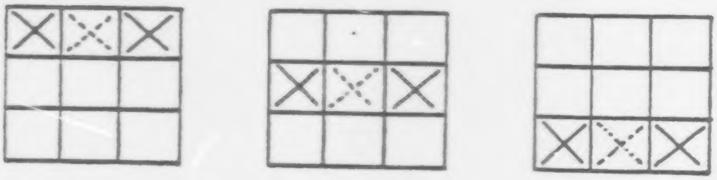
3. The grid mask is removed, the 15 second time is activiated and the examiner says and/or signs (for hearing impaired child), _"(Name)_, look".

4. Upon completion of each trial, the examiner records the frequency of visual contacts with each object and the mean frequency of visual contacts with stimulus objects on the data sheet. Mean frequency of visual contacts with stimulus objects is determined by dividing the total frequency of visual contacts with stimulus objects by the number of objects. Any comments concerning the trial may also be recorded at this time.

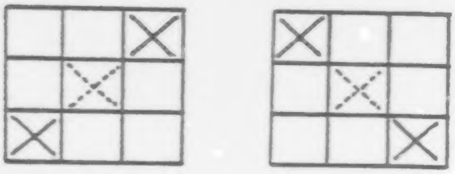
When more than one session is held in a day, a break should be scheduled between sessions to avoid eye fatigue in the child. It may also be necessary to allow the child to rest between trials and grid distances.



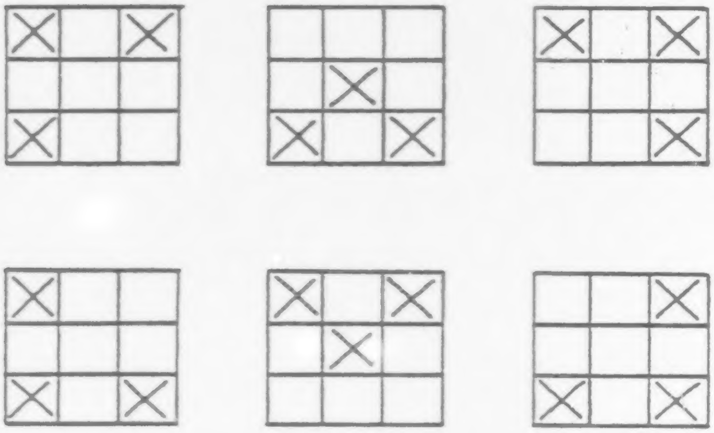
Vertical positions



Horizontal positions



Diagonal positions



Random positions

Figure 4: Illustrations of stimuli positions in grid

Tabulating and Graphing the Data

Three methods of tabulating data are recommended for visual scanning. These methods are: (1) mean frequency of stimulus visual contacts per position; (2) mean frequency per object array; and (3) mean frequency per distance. One method of graphing data is recommended. This method is a bar graph illustrating the rate of visual contacts with stimulus items for each array and both distances for each child.

Visual Scanning in a Sidelying Position

Procedures described for this position are designed to measure the frequency and mean frequency of visual contacts with stimulus objects in the scan path when the child is in a sidelying position.

Materials and Equipment

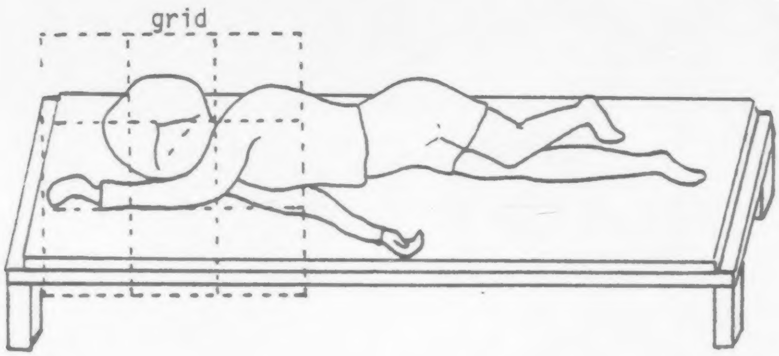
Necessary materials are appropriate data sheets, a fifteen second timer, and an elevated table mat or incline mat. The plexiglass grid and preferential items previously described (Refer to Visual Scanning in a Sitting Position) are also employed.

Observational Setting

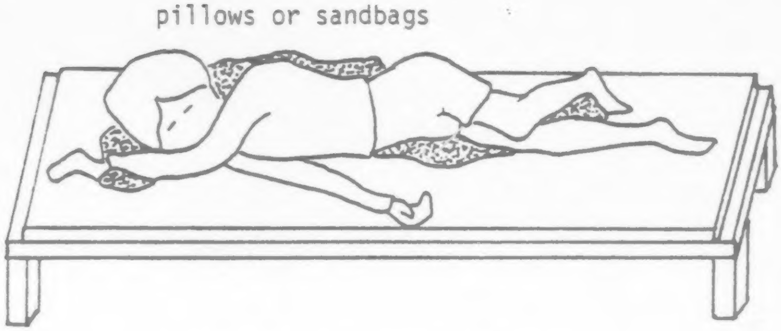
Measuring visual scanning in the sidelying position can take place in a classroom or in the home.

Positioning the Child

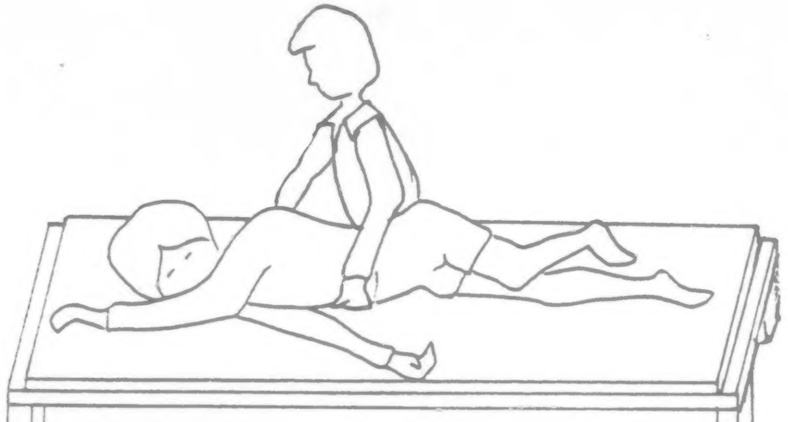
Place the child in a sidelying position on the incline or table mat (see Figure 5). Position the center section of the plexiglass grid even with the child's face. Pillows, sandbags, or adult support can be used if the child is unable to independently maintain a sidelying position. Reposition the child and start the trial over if he/she moves from the sidelying position during a trial.



Non-supported side lying position


pillows or sandbags

Supported side lying position



Adult supported side lying position

Figure 5: Illustrations of sidelying positions

Description of Behavior

The definition of visual scanning has been previously described (Refer to Visual Scanning in a Sitting Position).

Procedures for Measurement

Procedures for measurement of visual scanning have been previously described (Refer to Visual Scanning in a Sitting Position).

Tabulating and Graphing the Data

Procedures for tabulating and graphing the data have been previously described (Refer to Visual Scanning in a Sitting Position).

Visual Scanning in a Prone Position

Procedures described for this position are designed to measure the frequency and mean frequency of visual contacts with stimulus objects in the scan path when the child is in a prone position.

Materials and Equipment

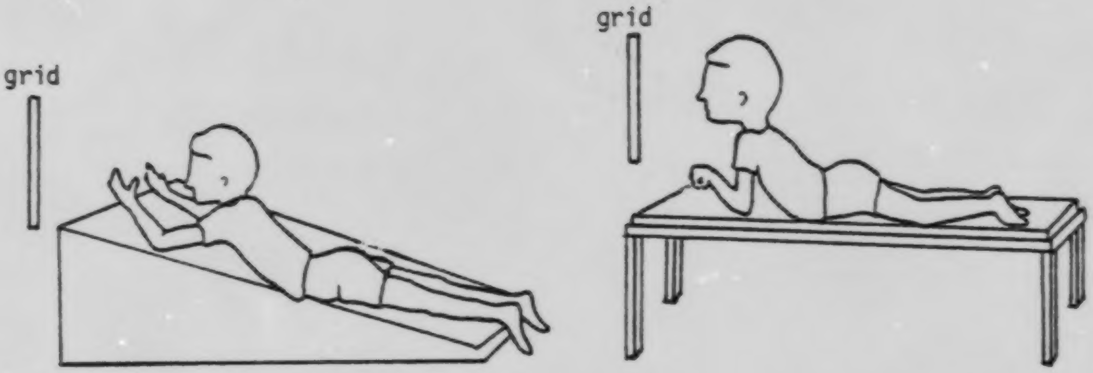
Necessary materials are appropriate data sheets, a fifteen second timer, and an elevated table mat or incline mat. The plexiglass grid and preferential items previously described (Refer to Visual Scanning in a Sitting Position) are also employed.

Observational Setting

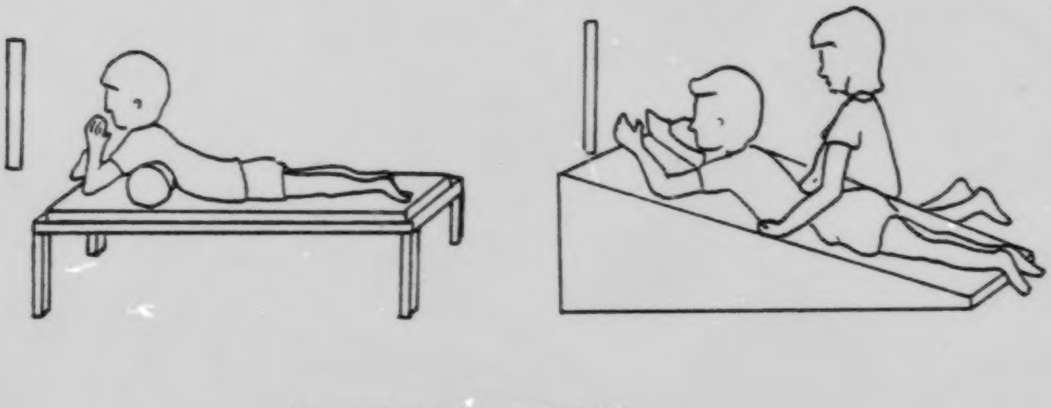
Measuring visual scanning in the prone position can take place in a classroom or in the home.

Positioning the Child

Place the child in the prone position on the table mat or incline mat (see Figure 6). The shoulders and head should be elevated. Pillows, sandbags, or adult support are used if the child is unable to independently maintain the position. The center section of the grid is positioned



Non-supported prone positions



Supported prone positions

Figure 6: Illustrations of prone positions

even with the child's face. Reposition the child and start the trial over if he/she loses balance or moves from the prone position.

Description of Behavior

The definition of visual scanning has been previously described (Refer to *Visual Scanning in a Sitting Position*).

Procedures for measurement

Procedures for measurement of visual scanning have been previously described (Refer to *Visual Scanning in a Sitting Position*).

Tabulating and Graphing the Data

Procedures for tabulating and graphing the data have been previously described (Refer to *Visual Scanning in a Sitting Position*).

Review of Measurement Instruments and Procedures for Assessing Reach, Grasp, Release, and Transfer Behaviors: Implications for Quantitative Measurement

by
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The University of Kansas
Early Childhood Institute

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[1] Preparation of this review was supported by funds to Doug Guess, Jane Rues, and Steve Warren as part of the Early Childhood Institute at the University of Kansas (BEH Grant #USOE 300-77-0308).

Fine motor assessment for skills acquired during the first year of life includes a description of the coordination of reach and grasp behaviors into functional prehension, purposeful retention of an object, and manipulation. The developmental sequence of the involved responses are listed, more or less completely, in a variety of standardized and nonstandardized assessment tools. However, regardless of whether the assessment instruments differentiate the various components of prehension, they all utilize a limited occurrence/nonoccurrence measure of response in order to monitor performance. Yet research on the development of the same fine motor responses describes a variety of observation methods, recording devices, and procedures. These procedures are impractical for most interventionists because of the expense of equipment, number of persons required, or time involved. The unavailability of precise recording procedures restricts measurement of prehension to very gross differentiations of critical responses. For example, the identification of a reach becomes a choice between "sweeps" or "directed reach." This insensitivity of our current measurement is further reflected by the fact that most assessment instruments require a response to be well established or spontaneous before credit is given to the child. This eliminates measures of the emergence of fine motor responses.

The importance of the reach and grasp responses is evident in almost all interactions with the environment. Those persons who do not develop functional prehension of some type are restricted in their ability to independently investigate, and therefore to learn, from their surroundings. A more accurate assessment of the emergence of a reach or grasp, or the small increments of change that occur in their development, will allow for a finer monitoring of training procedures, provide a method of accountability for the interventionists, and assist in the development of effective intervention procedures.

Standardized Developmental Scales and Checklists

Six standardized assessment tools which include an evaluation of fine motor development were reviewed. They were selected because they include behaviors appearing prior to 12 months, they sequence the behaviors in some developmental progression, they present the behaviors in measurable and observable terms, and they specifically identify items related to fine motor responses. Each instrument was reviewed with respect to the measurement or observation techniques used during the evaluation, directions given to the evaluator, and component behaviors identified as significant for the acquisition of prehension.

The observation or evaluation sessions are not extensively delineated by most of the assessments, leaving the setting and conditions of testing to the evaluator. The Assessment in Infancy (Uzgiris and Hunt, 1975) suggests that the evaluation can done in the home when the child is alert and playful. The Neonatal Behavior Assessment Scale (Brazelton, 1973, Note 1) suggests a more controlled setting, (in a quiet environment) beginning when the infant is asleep and gradually introducing specific stimuli while monitoring stages of awakening. The Denver Developmental Screening Test (Frankenburg, Dodds, and Fandal, 1970), and the Koontz Child Development Program (Koontz, 1974) do not delineate specifics of the evaluation setting. Only the Bayley Scales (Bayley, 1969) and the Developmental Diagnosis (Gesell and Amatruda, 1947) completely describe the setting. Specifications for the testing environment range from the size of the room and the furnishing to the type of mood desired and additional considerations possible for the comfort of the parent and child.

Directions for measurement vary between the assessment instruments. All six instruments score items as either occurrence or nonoccurrence data at various levels of specificity. None request measures involving time, even for those responses generally viewed as approach behaviors (i.e., movement of fingers, movement of arms, or swipes). The Koontz Child Development Program specifies that the response has to be spontaneous and naturally occurring rather than elicited, but no specific criteria for judging this response are given. The Neonatal Behavioral Assessment Scale, Developmental Diagnosis, Bayley Scales, Assessment in Infancy, and Denver Developmental Screening Test utilize both spontaneous observation methods and the presentation of stimuli to determine the occurrence of a response. However, most trials include a formal assessment of responses such as grasping pattern, reaching for distant objects, or activation following the visual presentation of a stimulus item. The Denver Developmental Screening Test, Koontz Child Development Program, and Neonatal Behavior Assessment Scale do not require the observation of all responses, but accept parental reports of such behaviors as hands together at midline, batting, or transferring objects.

The positioning of the individual during assessment, if indicated for separate trials or sessions, usually alternates between the supine and supported sitting positions. Standing or sidelying are not mentioned as positions either to initially assess reach and grasp behaviors, or as alternative positions. The Bayley Scales give general instructions for the arrangement of the evaluation setting with some notes referring to placement of the child in sitting or supine positions. Evaluation of more advanced grasps are done in a sitting position with a flat surface placed at elbow height. No indication is made whether the sitting position is supported or independent. The Developmental Diagnosis evaluates all initial reaching responses in the supine position with the sitting position used for more advanced reach and grasp responses. The Neonatal Behavior Assessment Scale moves from the use of supine to a position in which the child is held. Identification of behaviors specific to reach (i.e., tone of arm movements and hand to mouth) are only observed in the supine position because of the age of the child being evaluated. The Denver, the Koontz, and the Assessment in Infancy do not indicate what positions are to be used to observe which specific responses. The Denver does suggest a support surface for objects when assessing more advanced grasping patterns. None of the assessment instruments reviewed request observations of the same response in two or more positions, nor do they suggest how long a position should be maintained before the performance in that position is considered nonrepresentative.

The materials generally used to assess fine motor skills during the first year are a red ring, cube, pellet, raisin, rattle, and string. The Neonatal Behavioral Assessment Scale does not utilize materials, but scores on general muscle tone and hand to mouth facility. However, the Bayley Scales, Koontz Child Development, and Denver Developmental utilize the above items without delineating size and shape. Only the Developmental Diagnosis, in Appendix A of a more recent edition (Knobloch and Pasamanick, 1974), presents a list of test items with specific dimensions. Each of these dimensional characteristics could effect the individual's ability to grasp and retain, or retrieve the materials. The Assessment in Infancy suggests objects familiar and liked by the child. The possible size differentiation might further reduce the validity of the assessment for grasp, transfer, and release behaviors. The positioning of the stimulus items, whether dangled or placed, is inferred to be in the midline position. None of the assessment tools specify if the item should be in midline. Nor do they indicate the distance the object should be held from the child's body or the duration of the presentation. No alternative positionings of the materials are suggested, either for a secondary testing position or to specifically identify the ability to reach or grasp objects in a range of different positions. Finally, it is not clear what, if any, instructions, or verbalizations are to be given along with the presentation of the stimulus items.

The behaviors pinpointed during the early assessments of fine motor acquisition initially differentiate separate topographies for the reach, grasp, and release responses until the individual coordinates the action into one movement involving reach, recovery, and manipulation. Early reach is identified by the Denver Developmental Screening Test if the child moves both the arms and legs equally, by the Bayley Scales if the arms are thrust during play, or later if there is unilateral reaching. Early reach is identified by Developmental Diagnosis if arms activate with the presentation of stimulation and later if there is a two handed approach to items. The Assessment in Infancy identifies early reach if intensified and then repeated arm movements occur with stimulation. Reach responses measured by the Neonatal Behavioral Assessment involve arm movements characterized by smooth or jerky patterns, the size of the arcs, over-shooting, and hand to mouth facility. The Koontz Development Program does not assess reach as separate from early grasping. In this scale the identification of the development of the grasp begins first with an observation of the position of the hand, fisted or loosely open. But the position of the arm is always related to the activity of the hand. Only the Bayley Scales and the Developmental Diagnosis differentiate the type of grasping pattern utilized (ulnar, medial, or radial), while the other scales assess manipulation skills by identifying responses such as recovering, transferring, banging, rotating and regarding, and releasing objects. The establishment of a mature pincer grasp is assessed specifically in Developmental Diagnosis, the Denver Developmental Screening Test, and the Koontz Child Development Program. The Bayley Scale and Assessment in Infancy do not specifically require thumb-finger opposition for credit on more advanced grasping activities. Release and transfer skills are identified less frequently and with less specificity than either reach or grasp. The Developmental Diagnosis deals with release incombination with the transfer response at forty weeks, the child "drops" a second cube to recieve a third. Voluntary release is not specified until over one year of age.

These six standardized assessment tools identify the behaviors observed during the development of grasp, reach, and the manipulation of objects. However, indepth assessment of the emergence of new responses, or variations of performance within responses, is severely limited due to inadequate measures and the lack of systematic instructions to the evaluator. The difficulty of adequate measurement of developing these behaviors was pointed out by Bayley (1969). "Items showing low test-retest reliability for the motor scale were more variable in type, involving 'emerging' skills in the areas of both fine and gross coordination and tasks requiring the examiner's assistance." (p. 22)

Non-Standardized Assessment Instruments and Procedures

There are a number of nonstandardized assessment tools which vary in the amount of the instructions provided for measurement, positioning of the child, and materials used. Of the eighteen nonstandardized scales reviewed, eight present directions on the administration of the scale, while the remaining scales only provide developmental lists of behaviors. All eighteen assessments were selected because they list some fine motor behaviors that occur during the first year of life, present the behaviors in a developmental sequence, and identify the behaviors in terms that can be operationally defined. The six assessment tools that give instructions for administration were reviewed in terms of the measurement techniques suggested, directions to the evaluator, and the sequence of behaviors to be identified. These instruments include the Callier-Azusa Scale (Stillman, 1977), The Down's Syndrome Performance Inventory (Hayden, Note 2), The Peabody Developmental Motor Scales (Folio and DuBose, 1974), The Learning Accomplishments Profile (LAP) (Sanford, 1974), The Madison Public School Early Childhood Fine Motor Checklist (Funkhouser, Amundsen, Hunt, Smith, Putzer, and Sipsma, Note 3), and The Marshalltown Project, Manual I, (Donahue, Montgomery, Keiser, Roecker, Smith, and Walden, Note 4), the Abilities of Babies (Griffiths, 1954) and Albert Einstein Scales of Sensory-Motor Development (Escalona and Corman, Note 5). The remaining 10 assessments were included in order to enhance the list of behaviors pinpointed as significant in the development of functional prehension. These include the Developmental Pinpoints (Cohen, Gross, and Haring, 1976), Early Intervention Developmental Profile (Moersch, Note 6), Infant Learning Program (Gentry, 1977), Performance Objectives Catalogue (Ingham Intermediate School District, 1977), The Manual of Alternative Procedures: Motor Development (McCormack, 1977), Project Memphis (Quick, Little, and Campbell, 1974), the Rural Infant Stimulation Program (RISE), (Holden and Cook, Note 7), The San Juan Program Checklist (Note 8), The Sequential Assessment and Teaching Guide (Falvey and Greenburger, Note 9), and the Tests for the First Years of Life (Frankl and Wolf, 1935). Procedural manuals for these ten assessments were either not avaliable or unattainable for further analysis of the assessment procedures.

The review of the measurement procedures outlined by the first six assessment tools includes a discussion of instructions about the physical environment or location of the evaluation, whether the response was to be formally or informally observed, how the response was recorded, whether parental reports were accepted, and how much training was required for the evaluator.

Four of the first eight assessments give some instruction as to the location or environment of the assessment. The other four instruments imply that assessment should take place in location convenient for the evaluator. The Callier-Azusa suggests that the assessment be conducted in the classroom, and only after the child has been exposed to that environment for two weeks. The intent is to observe behaviors that typically occur in this setting. The L.A.P. also suggests a familiar classroom for observation. The Madison Public School Fine Motor Checklist is essentially concerned with skills that exist in the environment, so the assessment or observations are encouraged to occur in as many natural environments as possible. Home and school settings are suggested with a general recommendation to also include work and leisure environments. Abilities of Babies gives an extensive discussion of how the testing environment should appear. The descriptions include the size of the room, color tones, furnishing, and mood that is being developed.

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All the assessment scales require an occurrence or nonoccurrence measure of a particular response. Four of the scales indicate how a trial is to be determined. The L.A.P., The Albert Einstein Scales, the Abilities of Babies, and the Callier-Azusa Scale to a lesser extent, provide guidelines for implementation of the assessment trials or the arrangement of the assessment observation. These scales also give guidelines for scoring the child's responses. Usually they are scored as credit, no credit, not applicable, or no opportunity to score. The Introduction to the Madison Public Schools Early Childhood Fine Motor Checklist points out that the responses to be observed are considered functional skills. Therefore the checklist is designed to assess how well "a child can perform a meaningful activity in his/her environment, without direct orders..." (p. 3). No systematic cues or materials are desired. Some of the scales do not require the actual occurrence or nonoccurrence of a response to be observed by the evaluator. The L.A.P. and the Peabody Developmental Motor Scale accept parental report for some select items, the Callier-Azusa encourages a parent to be included on the team of familiar persons evaluating the individual. None of the scales suggest any recording procedure other than the occurrence of the response. Some characterize this occurrence by such terms as "spontaneous," "functional," or "readily observable." The Albert Einstein Scales do require that a behavior must have been observed on atleast two separate occassions in order to recieve a score. However, measures involving time, portions of a response, or different typographies are not suggested. Nor do these scales give guidelines for the amount of training or performance required of the evaluator before the assessment can be considered valid or reliable. The Callier-Azusa, L.A.P., Peabody, Albert Einstein Scales,

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Abilities of Babies, and Madison Public Schools Checklist all encourage familiarity with both the items on the checklist and the individual to be assessed before proceeding, but they do not indicate how to determine when this has been achieved.

Each of the eight assessment scales reviewed does present some directions to the evaluator in terms of the positioning of the individual and the materials to be used. The most common positions available for assessment of fine motor skills acquired prior to one year are supine, prone, sidelying, and supported sitting. Of the assessments reviewed, the L.A.P. most completely describes positions in which to assess the individual skills. The L.A.P. specifies lying as "facedown" "on his stomach," or "on his back" (p. 33). The Callier-Azusa, Marshalltown, and the Down's Syndrome Performance Inventory rarely include positions with the description of different responses to be assessed. The three positions most often utilized are prone, supine, and supported sitting. The Madison Public Schools Checklist specifically does not indicate which positions are to be used to assess the skills because the responses are to be observed as they occur naturally. This would suggest assessing the skill in any position the individual assumes or maintains in the environment. However, this implication is not clear, nor is the data sheet for this checklist conducive to assessing the same skill in more than one position. Abilities of Babies describes different body positions and positioning techniques. Attention is given to insuring complete stability for both nonhandicapped and handicapped individuals. The Albert Einstein Scales suggest a variety of sitting, and supported sitting positions, i.e., mother's lap, infant seat. The option of using other positions is encouraged. "If the response is not forthcoming in the initial position, the examiner administers the same item in other possible positions." (pg. 2) However no other positions are suggested, nor are the positions in which the assessment occurred indicated on the data sheet. None of the assessment tools consider sidelying as an alternative position for the demonstration of prehension. When a position is indicated, no guidelines are presented suggesting how long to maintain an individual in the position while observing a response, or how often to rotate positions. Both considerations could significantly effect the performance capability of severely involved individuals.

All eight of the nonstandardized assessment instruments present directions or suggestions for the materials to use in the evaluation. The typical ring, rattle, cube, raisin, and string are included. The L.A.P., Callier-Azusa, Albert Einstein Scales, and to a lesser degree, the Marshalltown and Peabody Motor Development Scale, suggest a toy or favorite item to determine the presence of different responses. The size of the object is rarely indicated. The positioning of the material in relation to the child is even less frequently specified. The assumption is for the experimenter to place items in midline. It is not clear, however, at what distance the objects should be placed from the individual, for how long, or what instructions should be provided. Only Abilities of Babies specifies placing the object two to three inches from the hand. But a radial, medial, or ulnar location is not indicated. No assessment scale suggests positioning the items other than at the midline, either as an attempt to determine the extent of generalization of the response or to identify if the response occurs when the stimulus item is presented in any of a variety of positions.

The nonstandardized assessment instruments reviewed contain both a greater number and greater variety of items identified as relevant behaviors in the acquisition of functional reach and grasp than do the standardized assessment scales. The items listed can be categorized as behaviors involving reach, grasp, release, and then the coordination of these movements into transfer skills and object manipulation. The Developmental Pinpoints has the most extensive listing of behaviors involved in the development of grasp. The Marshalltown adds to this information by listing some levels of prompts at which an individual could perform a skill. The overall identification of the development of a reach is not as clearly or extensively differentiated as that of the grasp. The listing for reach jumps from identification of activation of arms with stimulation and extensor-flexor thrusting to reaches immediately for an object. Some assessments also include hand to mouth movements or swiping objects from the face or chest as components in the development of a reach prior to the coordination of a reach and grasp response.

Research in the Development of Reach and Grasp Responses

Some basic research has appeared dealing with reach as separate from a grasping response. Primary investigation was conducted by Halverson (1933) in the attempt to accurately record the development of reaching movements in infants. Motion picture stop-frame analysis was used to identify such components as lateral digression of the arm, absolute distance traveled, elbow movement, and amount of forward projection.

The variables under investigation centered around the accuracy of reaching movements in infancy, with descriptors identifying the course of accurate movement, the nature of earliest reaching movements and their development, the nature of errors in reaching, the uniformity in the nature of errors at a given age, the direction of errors, the nature of their corrections, the transformation of reaching patterns, the speed of movement, and the relative usefulness of the parts of the arm and trunk in reaching activities. Halverson studied eight children and followed the development of reach for each child from 12 to 60 weeks. During sequential four week age periods, each child was placed in a supported sitting position with a pellet or cube placed in front of him on a surface. Motion pictures were recorded of the reaching motion from an overhead and side view. Stop-frame analysis was used to identify movements during which the child's hand passed nearest to the object after leaving a position of rest and ending in another activity. Components of reach such as lateral digressions of the arm, absolute distance traveled, elbow movement, amount of forward projection, course of the hand in reaching, reach time, continuity of movement, hand elevation, etc., were identified across the 48 week age span. The information is presented in tables which give brief descriptions of the movements across ages.

McGraw (1943) attempted to chart the emergence and integration of a series of identified phases of reaching. Six phases were identified and the percent occurrence of these responses across infants of various ages was observed and represented in graphic form. The phases generally represented the following: A - newborn or passive with no overt response to stimuli; B - incipient flexor-extensor movements and/or rapid uncoordinated movements with arms; C - approach movements of upper extremities with movements of arms identified as circumductive, ataxic, and bilateral, and fingers extended or fisted with arm approach movements; D - manipulative and deliberate movements where reach is directed and the fingers are extended throughout motion with actual prehension occurring between the finger tips and thumb; E - a dimunition of the extension of the fingers while reaching and a glancing away when the motion is being completed; and, F - motion reduced to the essentials, with no gross movement involved. The figures presented in the study graphically depict the percent of occurrence of each phase across age in days, 0 to 1200. This method of representation clearly demonstrated the acquisition and then decrease or integration of each phase of responding as more developmentally advanced phases are acquired. Even though the reliability of the measurement procedures and the validity of the definitions can be questioned, this study is notable as an early attempt to represent the emergence and integration of a variety of reaching behaviors as a function of age.

White, Castle, and Held (1964) observed 34 institutionalized infants weekly for 10 minute periods while the infants were supine in their cribs. Following the observation period was a 10 minute standardized test session consisting of the presentation of stimulus objects to elicit visual pursuit, prehensory, and grasping responses. A multicolored-fringed party toy was presented to the supine infant in three position for 30 seconds. Starting position for the infant was identified when the arms were resting on the crib surface. The stimulus object was held 12" from the child to elicit visual attention of the infant at 45° left, 45° right, and midline. The object was later held stationary at 5" from the bridge of the child's nose. This study resulted in a description of normative sequencing of visually-directed reach across the first 6 months of life based on frequency analysis.

Seth (1973) also studied the monthly development of eye-hand coordination and "handedness" in 9 normal infants ages 20-52 weeks using motion picture analysis. Each child was seated at a table top and one of three objects (block, ball, or pellet) was presented at a standard medial position for 20 seconds. The following behaviors relating to reach were analyzed: hand and arm movements, crude frequency of all movements right and left hand taken together, percentage frequency of right, left, and bilateral movements, and total time spent in approach to, manipulation of, and exploitation of the test object. Tables and graphs displayed the information in relation to eye-hand coordination and handedness.

Most research identifing and measuring the reach response attempt to determine the relationship of reach to visual and auditory stimulation. These studies are included as examples of measurement methods. Freedman, Fox-Kolenda, Margileth, and Miller (1969) demonstrated characteristics of the overhead and lateral reaching responses of a blind infant placed in the supine position. The investigators attempt to determine which sensory mode the infant used first to guide the reaching response. At five months the infant reached overhead when a rattle was sounded, but only reached laterally if tactile stimulation followed the sound of the rattle. Reach was defined by whether the rattle was retrieved or not, implying that the physical components of a reach were already well established. Fraiberg, Seigel, and Gibson (1966) studied the search behavior of blind infants in terms of the topography of the reaching behavior in response to tactile and auditory stimuli. A stop-frame analysis was used with scoring done by agreement from a group of observers. Examples of topographies pinpointed included hands motionless, hand continues with previous motion, child conducts random search, search patterns become organized, groping gestures, orients head with arm, directed reach and recovery, etc.

McDonnell (1975), studied whether the hand had to be in the sight of the infant for reaching to occur and compared the reaching of neonates and four to five month olds when sight of the hand was and was not distorted. Videotape from a position directly above the infant recorded the path of approach to an object over a measurement surface marked off in centimetered concentric circles around the midpoint of the placement of the object. A miss path was differentiated from a hit path if the object was passed while reaching was attempted. In addition, correction paths were observed when the direction of the hand crossed the line of fixation. The results indicate that view of the hand increases accuracy of the reach response of older infants with fewer corrections enroute to the target. A demonstration of the intention of reaching in the neonate was made by Bower, Broughton, and Moore (1970). They defined reaching as being oriented and expressing a distal aim or intention. Aim was determined by a film analysis of the angular relationship of the position of the hand/arm extension, the object, and the middle of the infant's body. Intent was determined by the infant's response after the reach if the object was contacted. Crying tended to result after reach for the visual projection of an object rather than for the real object. No crying occurred if reach encountered a real object.

Some of the developmental information of the earlier research on reach has been included in selected assessment tools. However, a finer analysis of the movement arcs of the arms, the patterns, or the total time and distance involved in a reach have involved equipment and procedures too involved for most classroom application. Yet these definitions and techniques can provide a beginning for the development of applicable classroom procedures when assessing the emergence of reach responses.

Even fewer research articles have attempted to relate the effect of the reach response on the grasp. Halverson (1937, C) studied the relation of arm position to readiness and strength of the early grasping response. He restrained the infant's arm in predetermined positions, either independently assumed or forced positions. Halverson then tested the elicited grasp response by resistance to withdrawal of a rod. His measurements were loosely defined in such terms as firm, strong, or weak. The elicited response was strongest when the arm was extended, and weakest when the arm was flexed at the shoulder. In a later study, Kopp (1974), examined the variety of reach approaches when the advanced radial palmar grasp was predominant. Observation periods were divided into 60 second segments to evaluate the anticipatory motor adjustments of the arm, and 120 second segments to evaluate the retention and use of an object. An object was placed in a predetermined location while the infant was in a supported sitting position. Examples of the observation code for the approach to an object include: plane of approach in direct line or circuitous, speed of approach (less than 2 seconds or more than 3 seconds), hand position of approach (some rotation or completely rotated), and accuracy of approach. Examples of the observation code for retention include: the position of the first hand to contact the cube, first finger position of cube, finger spread, and type of grasp. Finally, movements of the second arm were also recorded. Kopp concluded that there are qualitative differences in reach and grasp actions even among normal infants. The additional factor of the range of movements present in the reach and grasp of handicapped individuals greatly increases the problem of coding responses for a reliable classroom assessment tool.

The characteristics of the grasp response were investigated early and thoroughly by Halverson. Norms were established for the relation of clinging strength to finger length and the diameter of the rod (Halverson, 1937 c), and clinging strength as compared with the right and left hand (Halverson, 1937 b). The question whether infants discriminate grasping objects by texture, by the strength of the pull on the rod, and/or by presensitization with rough or smooth objects was also identified (Halverson, 1937 a). The procedure for evaluating the grip involved measuring what proportions of the infants own body weight was supported by clinging to a rod when raised off the ground. The procedure for evaluating finger strength was similar. Discrimination was defined by whether or not the infant retained the object. The particularly human characteristic of thumb-oppostion was identified in terms of the digital postures of the thumb and fingers when grasping a variety of objects (Gesell and Halverson, 1936). The children were filmed in supine and sitting position with stop-frame analysis used to determine the position of the arm, hand, and fingers. Motion pictures were also used in a later study to document the development of the automatic grasping response in infants (Twitchell, 1965). The characteristics of finger, hand, wrist, and elbow positions during the avoiding response, traction response, reflexive grasp, and automatic grasp were described. As with the reaching response, the norms for a grasp were established prior to the development of most assessment tools. However, their inclusion as items to be evaluated has been prohibited because of a lack of reliable and valid measurement techniques that are applicable to the classroom setting.

A Developmental Sequence for Fine Motor Skills: Implications for Quantitative Measurement

The sequences identified through the basic research and expanded and translated into observable events on standardized and nonstandardized assessment tools are more than adequate in describing the normal development of reach and grasp. Figure 1 reflects the amount of information available for reach and grasp compared with the limited amount of data reflecting the development of transfer skills and a release. There is a conspicuous lack of research pertaining to the development of release or the utilization of transfer. The only identified source of systematic observation was by Gesell (1940). Gesell's observations during the first years of life show no release during the first 28 weeks. From 28 to 40 weeks infants are only able to release by inadvertantly dropping an object or by release against a resisting surface. At 44 weeks of age children develop a voluntary drop and at 52 weeks are able to place objects, drop proficiently and occasionally throw. From Figure 1 it is obvious that development of manipulation comprises both a horizontal and vertical progression with various components beginning, developing, and integrating with more complex responses at different points in time. Figure 1 is a summary of the developmental milestones selected from all the standardized and nonstandardized assessment tools reviewed. It represents the general consensus of the sequence of responses and the approximate age at which they usually occur. Discrepencies in the developmental progression or actual emergence of behaviors listed in the various assessment instruments were resolved by considering the placement of each skill by the majority of standardized tools. Figure 1 reflects the separate development of the component skills of reach, grasp, midline skills, and release as each becomes integrated into a higher level of functioning. Figure 2 displays the progression of the major component parts as they develop into the more general target skill of manipulation. Figure 2 was developed as a logical representation of the relationship of the component parts. Each cluster of skills has the potential of developing separately from the other skills listed, and each element, 1 or 2, within a cluster can develop without the occurrence of the other element. However, both elements within a cluster on line A must be acquired before each item listed on line B can be completed developed. The same progression holds for the development of the target skill, manipulation , on line C. Assessment instruments attempting to identify the development of manipulation skills with handicapped and non-handicapped individuals must allow for monitoring the emergence of each skill separately and as it becomes integrated into higher performance patterns in order to accurately describe the potential of each person.

FIGURE 1

A listing of behaviors describing the development of functional manipulation; the integration of reach, grasp, and midline skills. The sequence was compiled as a summary of items listed on the standardized and nonstandardized assessment tools reviewed in this paper.

FIGURE 1
MANIPULATION

Months	PREHENSION			
11-12	Compares by bringing together in midline			
	carries two objects in one hand			
10-11	holds with one hand and fingers with other		MIDLINE SKILLS	RELEASE
	pincer grasp	directed reach	combines objects	voluntary release
9-10	attempts to secure 3 cubes	reaches for object out of reach		
8-9	radial digital grasp	reaches with index finger leading	claps hands	
	3-jaw chuck			
7-8	radial palmar grasp	reaches with fingers over extended	transfers objects	
6-7	grasps with raking	reaches with arm in midline		release with arm stabilized
	turns and regards			
	holds two cubes pronates forearm rotates wrist			
5-6	GRASP	REACH		
	medial palmar grasp			
4-5	pulls ring to retrieve hit, shakes, waves grasps voluntarily	reaches directly object to mouth	object to mouth	involuntary-drops cube when given another
3-4	carries ring to mouth thumb not opposed	recovers rattle from own chest		
2-3	grasps with reach	sweeping reaches	fingers together	
	grasps and retains for 5 seconds			
1-2	ulnar-palmar grasps of objects	arms activate with stimulation		
	hands open and close	circular motions	hand to mouth	hands open and close
	hands loosely open			
0-1	hand fisted close around object	flexion-extension mass movements		

FIGURE 1 - DEVELOPMENTAL LISTING OF BEHAVIORS LEADING TO MANIPULATION

FIGURE 2

A flowchart representing the independent development of prehension, midline, and release skills and their relationship to functional manipulation.

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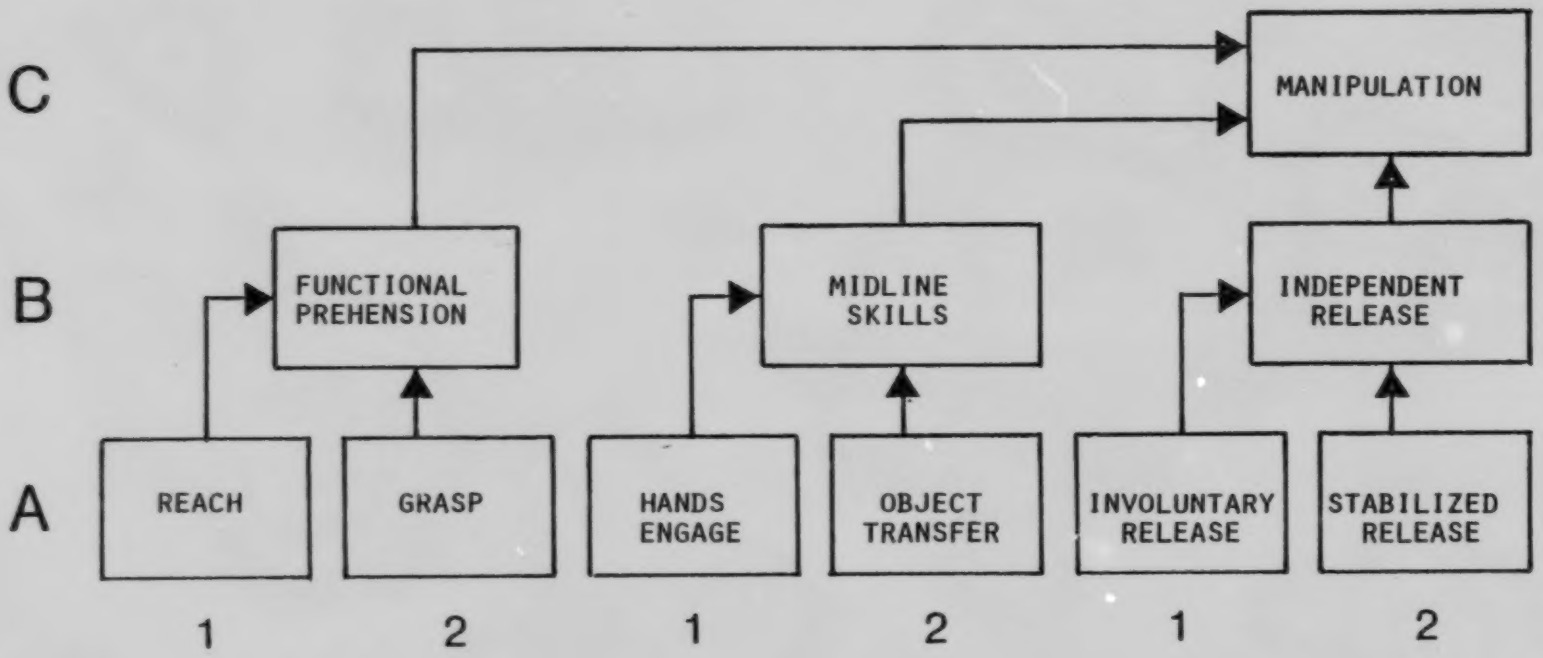
C
B
A
MANIPULATION
FUNCTIONAL PREHENSION
MIDLINE SKILLS
INDEPENDENT RELEASE
REACH
GRASP
HANDS ENGAGE
OBJECT TRANSFER
INVOLUNTARY RELEASE
STABILIZED RELEASE
1
2
1
2
1
2

Figure 2:Manipulation Progression

NOTES

1. *The Neonatal Behavior Assessment Scale* (Brazelton, 1973) was included specifically because of the descriptors for the neonate's hand movements. Unlike the other tools reviewed, it is not the function of this scale to provide an ongoing assessment of a child's development.
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FINE MOTOR

Procedures for Measuring
Reach

by

Deborah Dilley Proctor[1] and Marilyn Mulligan

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[1] The procedures reported in this study were taken from a master's thesis conducted by Deborah Dilley Proctor that was submitted to the Department of Special Education at the University of Kansas in October, 1979.

Measuring Reach

Procedures for measuring the fine motor skill of reach are described below. These are an improvement over previous procedures typically utilized for the assessment of reach because of the further specification of what component behaviors are involved, the use of duration as an indicator of the maturity of the reach, and clearer guidelines for the evaluation process.

The descriptors of reach usually identified have been expanded from typical items such as "swipes" and "reaches directly" to include measures of no movement or movement. If there is movement, the categories are further specified into the duration of the movement and whether the movement resulted in contact with the item, was a direct movement, and required support from the test surface.

The evaluation situation is extensively specified. The procedures suggest that each child be evaluated in those positions most appropriate to his or her current level of functioning. Positions described are sidelying, sitting, supine, and supported standing. The setting of the evaluation is in both a structured or unstructured environment with materials attractive to the child yet of a specified size. The trials for the actual assessment of the reach response are delineated by the cues, presentation of the stimulus items, and the determination of the end of a trial. Finally, the actual criteria for assessing if a response did or did not occur are given for each behavior involved in the reach response.

Reach in the Sidelying Position

These procedures are designed to measure the reach response in the sidelying position. Descriptors identified as involved in the reach response are the distance of the object, movement occurring in the arm, contact of the object with the hand, support required for the hand or arm, and duration of the reach response.

Sidelying is a "neutral" body position, one in which gravity and postural reflexes have little influence on the child's body and extremity movement. Therefore, sidelying tends to be most appropriate for those individuals who are more physically involved.

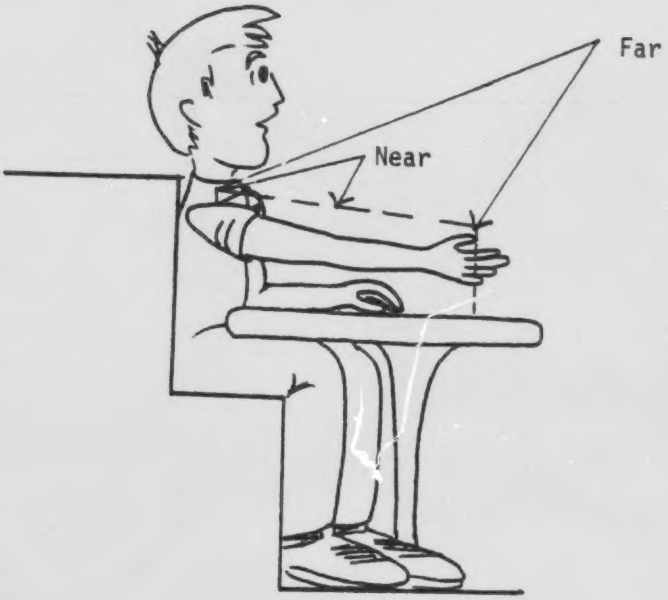
Materials

Tape measure. A plastic or cloth "sewing" tape measure is used to initially measure the full length of the child's arm from the shoulder joint to where the fingers start on the hand (metacarpalphalangeal joints). (See Figure 1) It is also used during stimulus presentations to measure the "far" and "near" distances from the child's shoulder.

Stimulus objects. Stimulus objects include any object, toy, materials, etc. accessible to the examiner that appear to be interesting to the child. It is suggested that these objects be no larger than 5" x 5" x 5". For consistency and expediency, the first materials utilized are the traditional ring, bell, cube, and cylinder so that the teacher may simultaneously measure the child's abilities to grasp and release the object. However, if these items do not sufficiently stimulate a reaching response or arm movement from the child, they should be replaced by toys found to be more salient. Stimulus characteristics that may be more interesting to a child include: (a) visual components - bright, vivid colors and/or movement; (b) auditory components - novel, clear sounds, and/or (c) tactile components - varying textures. For example, if the child being tested

Figure 1

Use of Tape Measure to
Determine "Near" and "Far" Distance
of Stimulus Objects


Far
Near

is visually handicapped, the stimulus characteristics should include both auditory and tactile components. Examples of appropriate stimulus objects include: blocks, bells, squeeze toys, rattles, small pull toys with sound and movement, and toy cars.

Masking tape. One-inch wide tape is used in small pieces (½ to 1" long) to mark the six stimulus positions on the testing surface.

Blanket or mat and sandbags. Items needed for positioning.

Measurement Materials. A data sheet (Figure 2), clip board, pencils, and stop watch are needed to record the child's performance.

Observation Setting

Reaching abilities are observed and assessed when the child is visually and/or socially alert and compliant. The optimal time of assessment is early in the day, 1/2 to 1 hour after eating and before the child is involved in the daily school/home activities and routine. If the child cries or tantrums at any time during testing, assessment is discontinued until the child is quiet and compliant. If the child seizures, becomes sick, or falls asleep, the assessment is discontinued until a later date. The observation setting is either the child's classroom or home, in a location where there are few outside distractions (visual and auditory).

Structured setting. Observations are made in this setting when the assessment of reach is the primary objective. The distance and size of the stimulus objects are monitored as well as the total time of stimulus presentation. The setting is free of extraneous distractors.

Unstructured setting. Observations in this setting are considered an informal evaluation of the reach response. The child is placed in an appropriate position for leisure activity or work. Observations are made while other activities are occurring.

Figure 2

Data Sheet for the Measurement of
Reach in the Sidelying Position

FM(R)7

REACH DATA SHEET

Subject ______________________ Examiner ________________

Date ________________________ Observer ________________

Arm Length ___________________ Reliability ______________

Body Position: Sidelying Structured Unstructured

Position of Stimulus Object	No Movement		Movement No Contact		Contact		Direct		Indirect		On		Off		Time						COMMENTS
	R	L	R	L	R	L	R	L	R	L	R	L	R	L	0-3	3-6	6-9	9-12	12-15	over 15	
Eye 1 2 Far 3																					
Eye 1 2 Near 3																					
Chest 1 2 Far 3																					
Chest 1 2 Near 3																					
Stomach 1 2 Far 3																					
Stomach 1 2 Near 3																					

FM(R)8

Positioning the Child

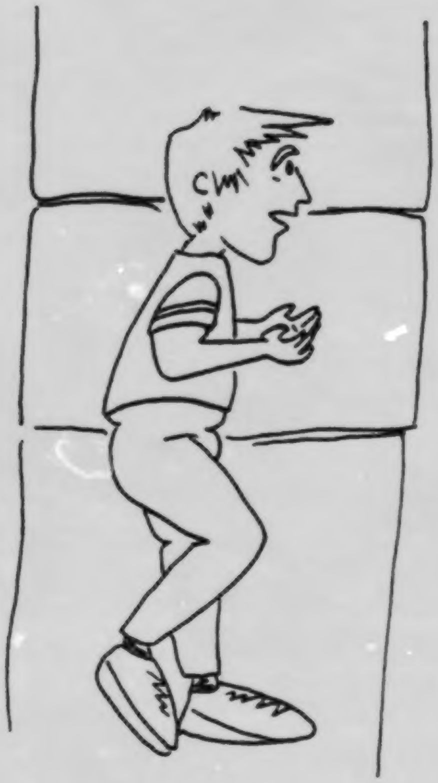
Place the child on either his/her right or left side on the floor or on a mat. An individual who is more physically involved or limited on one side more than the other (e.g. spastic hemiparesis) is placed so that the best arm is on the top. In a sidelying position, the child's head is slightly bent forward (flexed), the hips and knees are slightly bent (flexed), and the shoulders are rolled forward (shoulder protraction). (See Figure 3) If the child's muscle tone is more than normal (hypertonic or spastic), the child should be relaxed prior to positioning so that the above described position is easily elicited and maintained. Maintenance of the position is either independent or with support. The examiner can provide support, if needed, by sitting behind the child on the floor and using his or her legs to keep the child's head forward, the hips and knees bent, and maintained in the sidelying position.

Sandbags may also be used in quantities and locations needed (i.e., behind the child's buttocks, shoulders, thighs, knees, head, and in front at the child's stomach) to maintain the sidelying position.

The child should remain in this position as long as it takes to measure reaching responses at the various distances and angles. However, the child's tolerance for this position may range from a few minutes to a maximum of twenty to thirty minutes. Discontinue the session when there are indicators of fatigue such as a decrease in head control, irritability, drowsiness, etc. Return to the assessment as soon as the child is alert and responding characteristically.

Figure 3

Child in Appropriate Sidelying Position



FM(R)11

Description of the Behavior to be Measured

The observations of arm-hand movements are measured by the occurrence or nonoccurrence of movement and contact with the stimulus object, the type of movement utilized, the use of the support of the testing surface if contact is made, the duration of the arm movement, and the arms utilized in the movement. The following coding system (See Figure 2) is used to measure the child's responses to stimulus presentations:

No movement. From the child's starting position, no obvious change in the angles of the elbow or shoulder joints (less than 15°) is observed in the 15 second stimulus presentation time limit. Movement of the fingers and/or wrist without accompanying change in the angle of the elbow and/or shoulder is considered "no movement". The right and left arms are scored separately. When "no movement" is scored, no other box on the data sheet, except "Time-over 15", is scored.

Movement no contact. From the child's starting position, an obvious change in the angles of the elbow and/or shoulder joints (15° or more) is observed during the 15 second stimulus presentation time limit. The child does not touch the stimulus material with any part of the hand (palm, fingers, back, side, etc.). The right and left arms are observed and scored separately. When "movement no contact" is checked, the type of movement used, "direct or indirect" for that hand must also be recorded.

Contact. From the starting position, an obvious change in the angles of the elbow and/or shoulder joints is observed (15° or more) resulting in contact of any part of the child's hand (palm, fingers, thumb, back, side, etc.) with the stimulus object. The right and left arms are scored separately. If "contact" is checked, the type of movement (direct or indirect) and whether the movement is "on or off" the testing surface must also be recorded for that arm.

Direct. From the starting position, the child's arm and hand follow the most direct (imaginary straight line) path to the stimulus object without any movement varying from this path during the stimulus presentation. Direct may be checked for "movement without contact" or "contact". The right and left arms are scored separately.

Indirect. From the starting position, the child's arm and hand deviate from the most direct path (imaginary straight line) from the starting position of the hand to the stimulus object. This movement may be circuitous, composed of lateral swipes, or jerky and unsmooth in nature. "Indirect" may be checked when there is either "movement without contact" or "contact".

On surface. From the starting position, the child's hand and/or arm touches the testing surface (floor or mat) at any point during the stimulus presentation. Touching the hand and/or arm to the testing surface simultaneously when making contact with the toy is not considered to be "on" the testing surface. This code is checked only when contact is made. The right and left arms are scored separately.

Off surface. From the starting position, the child's hand and arm do not touch the testing surface during the stimulus presentation. However, the hand and/or arm may contact the floor or mat upon simultaneous contact with the stimulus object. This code is checked only if contact is made. The right and left arms are scored separately.

Time. There is a 15 second stimulus presentation time limit if no movement occurs or if movement has stopped for at least two seconds prior to 15 seconds. Otherwise the session continues and the duration of movement is recorded until contact is made or until movement stops for at least two seconds. On the data sheet (Figure 2), time is divided into three second blocks (0-3, 3-6, 6-9, 9-12, 12-15, and over 15). The appropriate time block is scored when contact occurs. The "over 15" box is checked when the 15 second presentation time limit has expired and no movement has occurred or movement has stopped two seconds without contact being made. If movement continues over 15 seconds, the actual duration of movement (in seconds) may be recorded in the "over 15" time block. This duration is recorded until that point when movement stops or until movement stops for two seconds or more.

Procedures for Measurement

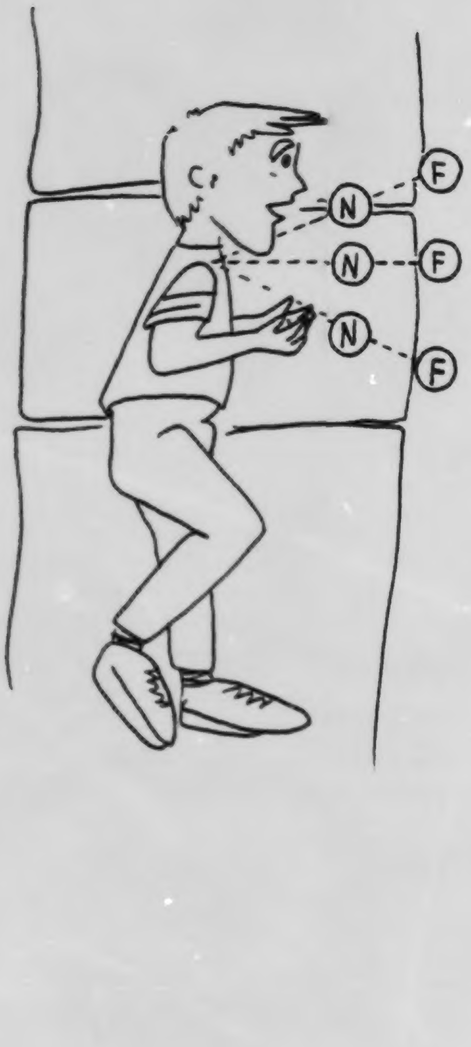
In the sidelying position, the testing surface is either the floor or a mat. The three stimulus positions are at the child's eye, chest, and stomach level at both far and near distances (See Figure 4). The far distance is the maximum distance the child could reach as determined by the measurement of the child's arm length from the shoulder to the second joint of the fingers, the metacarpalphalangeal joints (See Figure 1). The near distance in each stimulus position is one-half the child's arm length. Therefore, six stimulus positions are listed in the far left column of the data sheet (see Figure 1) for the sidelying position. They are: eyes far, eyes near, chest far, chest near, stomach far, and stomach near. Three trials are performed in each of the stimulus positions for a total of 18 trials. The order of the stimulus position presentations depends upon the discretion of the examiner and the performance of the child.

Once the child is positioned in sidelying, the examiner places and

Figure 4

Six Stimulus Positions

When Child is in Sidelying


F
N
N
F
N
F

holds the end of the tape measure on the child's top shoulder and extends the opposite end of the tape at an angle up toward the child's eye level. The far distance (child's arm length) and the near distance (1/2 the child's arm length) is then marked with a piece of masking tape on the floor or mat. The same procedure is followed for determining the chest level distances. One end of the tape is held at the child's shoulder and the other end is extended out from the child's shoulder in front of the chest. The far and near distances are marked with pieces of masking tape. The stomach level distances are determined pulling the tape down so that the far end of the tape is across from the child's umbilicus. Both distances are again marked with tape. When presenting stimulus items at the different distances and positions, the edge of the toy nearest to the child should be at the piece of tape.

Once the child is positioned and the stimulus positions are marked, the testing trials begin. The procedure consists of the following steps:

1. Gain the child's attention by presenting the toy visually and auditorily (tactually if the child is visually impaired).

2. Move the stimulus item to the desired position.

3. Either wait briefly for the child to stop arm activity near the body or place the child's arms in a starting position with elbows bent up near his/her chest. If the child resists the physical restraint, hold him/her gently until relaxation occurs.

4. Give the command " (Name), touch toy" while simultaneously releasing his/her arms.

5. Start the stop watch.

6. Observe the arm/hand movement.

7. Periodically activate the stimulus item (every 3-4 seconds) to prompt the child to reach and touch it.

8. Stop the stop watch at 15 seconds if no movement has occurred or if movement has stopped for at least two seconds.

9. Continue timing until either contact is made or movement stops in both arms for at least two seconds.

10. If contact is made, reinforce the child with verbal praise and activation of the toy.

11. Record observations according to the code on the data sheet (Figure 2).

Follow the same procedure for three trials in each stimulus position.

Tabulating the Skill Data

In order to determine the percentage of movement the child demonstrates with each arm to each stimulus position, total the number of times the child moved, with or without contact, one arm (right and left arms figured separately) with a stimulus in a specified position and divide by the total number of opportunities the child had to reach that position. For example, if the child moved his or her right arm 12 times out of 12 trials, the percentage of movement with the right hand in the right near stimulus position is 100%.

To determine the percentage of contacts with each arm to an item in each stimulus position, total the number of times the child contacts the item (right and left arms figured separately) in a stimulus position and divide by the total number of movements, contact or no contact. For example, if the child contacts an item in the right near position with his or her right hand ten times out of 12 times, the percentage of contacts with that hand in the right near stimulus position is 83%. In order to determine what percentage of movement results in "no contact", subtract the percentage of "contacts" from 100%. The percentage of "no contact" in the above example is 17%.

To determine the percentage of direct movements with each arm to each stimulus position, total the number of times the individual has direct movement (right and left hands figured separately) to that stimulus position and divide by the total number of movements, contact and no contact. For example, if the child has direct movement with the right hand zero times out of 12 times, the percentage of direct movement with that hand in the right near stimulus position is 0%. In order to determine what percentage of movement was "indirect", subtract the percentage of "direct" movement from 100%. The percentage of "indirect" movement in the above example is 100%.

To determine the percentage of "off the surface" reaches with each arm in each stimulus position, total the number of times that "off" surface is recorded (right and left hands figured separately) to that stimulus position and divide by the total number of contacts. For example, if the child keeps his or her right hand off the surface eight times out of ten times he or she contacts the time with his/her right hand in the right near stimulus position, the percentage of "off surface" is 80%. In order to determine what percentage of contacts are made with the arm/hand "on" the surface, subtract the percentage of "off surface" from 100%. The percentage of "on surface" in the above example is 20%.

To determine the percentage of times the child contacts the item in each time block, total the number of times each time block is recorded for that stimulus position and divide by the total number of times the child contacts the item (with either the left or right hands) in that stimulus position. For example, if the child contacts the item eight times in the 0-3 second period out of the 12 times he or she contacts the toy (contacts two times with the left and ten times with the right hand) the percentage of contacts under three seconds is 67%. If the child contacts the item four times in the 3-6 second time block out of the 12 times he or she contacts the item, the percentage of contacts made in 3-6 seconds is 33%.

Reach in the Sitting Position

These procedures are designed to measure the reach response in an independent or supported sitting position.

Materials

The stimulus items and materials for measurement have been previously described (Refer to Reach in the Sidelying Position.)

Materials necessary to maintain and support the child in the sitting position may vary. A range of equipment is available and appropriate for children who do not sit independently, i.e., travel chair, wheelchair, adaptive chair, infant seat, high chair, etc. A tray or table is needed to place before the child.

A second data sheet (Figure 5) is used to identify stimulus positions on a plane perpendicular to the child's body position rather than parallel, as in the sidelying position. This data sheet (Figure 5) is appropriate for the sitting, standing, and supine body positions.

Figure 5

Data Sheet for the Measurement of Reach in the Sitting, Supine, and Standing Positions

REACH DATA SHEET

Subject ____________________ Examiner ________________

Date ____________________ Observer ________________

Arm Length____________________ Reliability ________________

Body Position: Supine Sitting Standing Structured Unstructured

Position of Stimulus Object	No Movement		Movement No Contact		Contact		Direct		Indirect		On		Off		Time						Comments
	R	L	R	L	R	L	R	L	R	L	R	L	R	L	0-3	3-6	6-9	9-12	12-15	over 15	
Right 1																					
2																					
Far 3																					
Right 1																					
2																					
Near 3																					
Mid 1																					
2																					
Far 3																					
Mid 1																					
2																					
Near 3																					
Left 1																					
2																					
Far 3																					
Left 1																					
2																					
Near 3																					

FM(R)22

Observation Settings

The two observation settings suggested for the measurement of reach have been previously discussed. (Refer to Reach in the Sidelying Position.)

Positioning the Child

Any sitting position in which the child can adequately function is appropriate for assessment. Varying amounts of support may be needed, depending on the involvement of the child. The appropriate position consists of the body in good alignment, the hips and knees bent at a 90 degree angle, and the feet flat and supported (See Figure 6). The chair may be a wooden chair with a table placed before it or an adaptive chair with a tray. The child is maintained in the sitting position as long as it takes to measure reaching responses in all the stimulus positions or until the child shows signs of fatigue. (Refer to Reach in the Sidelying Position).

Description of the Behavior to be Measured

The description of the behaviors to be measured have been previously described. (Refer to Reach in the Sidelying Position).

Procedures for Measurement

The testing surface is either a table or a tray that fits onto the chair and is positioned at the elbow level of the child. The six stimulu positions are far and near at right, midline, and left of the child's body (See Figure 7). The tape measure is again placed on the child's right and left shoulders and extended the length of the child's arm to the testing suface (see Figure 1). For the midline stimulus positions, the tape measure is held at either the right or left shoulder and extended the length of the child's arm to the testing surface directly in front of the middle of the child's trunk or sternum. Pieces of masking tape are used to mark the far and near distances in the right, left, and midline positions. The remaining measurement procedures have been previously discussed. (Refer to Reach in the Sidelying Position).

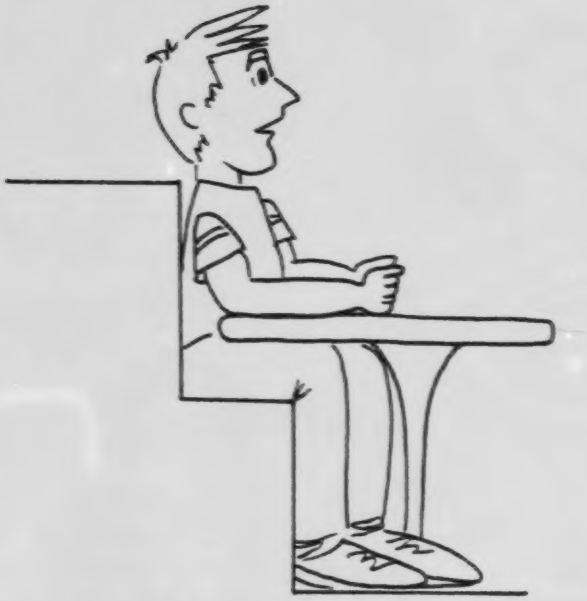
Tabulating the Data

Procedures for tabulating the data have been previously discussed. (Refer to Reach in the Sidelying Position.)

Figure 6

Child in Appropriate

Sitting Position

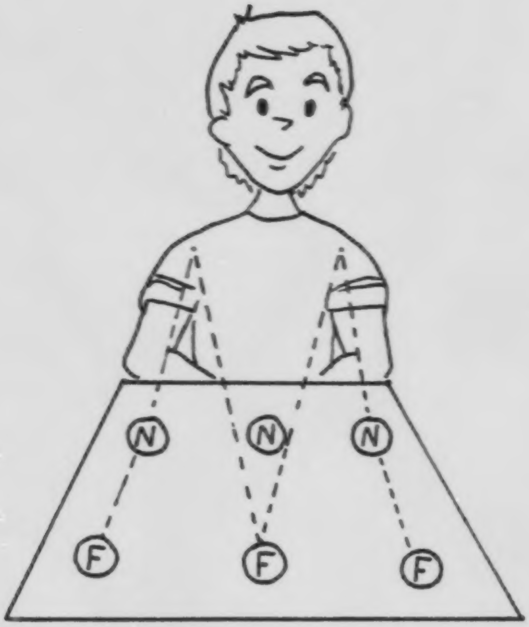


FM(R)26

Figure 7

Six Stimulus Positions

When Child is in Sitting



FM(R)28

Reach in the Supine Position

The following procedures are designed to measure the reach response in the supine position. Supine is an appropriate position to measure reaching skills among some developmentally "young" children. Although other children, depending on their handicapping condition, may have extreme difficulty lifting their arms in the supine position because of the gravity factor. Usually supine is the first position in which children begin to reach for objects.

Materials

The stimulus items and materials for measurement have been previously described. (Refer to Reach in the Sitting Position.) In addition, the following procedure is used to measure the arm position of the stimulus item suspended over the child. Cut a piece of heavy white thread the length of the child's arm plus an additional 1/4 inch. The extra length is for taping the thread to the stimulus object. The thread hanging down from the toy is used to gauge the distance of the toy from the child's body in the three far positions. Fold the thread in half to measure the three near positions (See Figure 8).

Observation Setting

The two observation settings suggested for the measurement of reach have been previously described. (Refer to Reach in the Sidelying Position.)

Positioning the Child

Place the child in supine on the floor or mat. Maintenance of this position may be achieved by placing sandbags, pillows, etc. on either side of the head and trunk as necessary (See Figure 9). The examiner

Figure 8

Determining "Near" and "Far"
Positions When Child in in
Supine

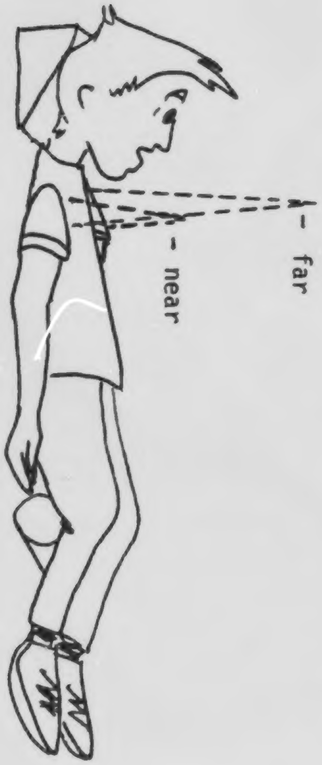
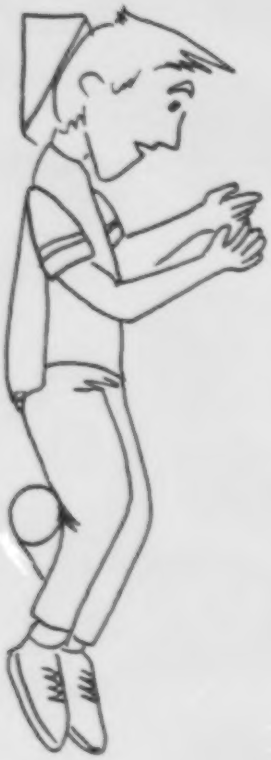

- near
- far

Figure 9

Child in Appropriate
Supine Position



FM(R)33

may also position his or her body to support the child, i.e., examiner places his/her legs down both sides of the child's body. A small pillow placed under the child's head and at the base of the hips under the thighs may help keep the child in a slightly flexed position.

Description of the Behavior to be Measured

The description of behaviors to be measured have been previously discussed. (Refer to Reach in the Sidelying Position.)

Procedures for Measurement

Since the child is in the supine position, no testing surface is used. A thread, the length of the child's arm, is taped to the near edge of the stimulus toy and dropped down so that it is touching the child's shoulder (See Figure 8). This is a nondistractible way to determine the near and far distances of the stimulus object. The thread is held so that the end closest to the child touches the right shoulder for the right stimulus positions, either the right or left shoulder for the midline positions, and the left shoulder for the left stimulus positions. The right and left stimulus positions are directly over the appropriate shoulder, the midline stimulus positions are directly above the middle of the child's chest or sternum. The remaining measurement procedures have been previously discussed. (Refer to Reach in the Sidelying Position.)

Tabulating the Data

Procedures for tabulating the data have been previously discussed. (Refer to Reach in the Sidelying Position.)

Reach in the Standing Position

These procedures are designed to measure the reach response in a supported standing position. A supportive standing device is nonfunctional unless a tray or table is readily available. For the examiner, this position creates an ideal situation for placing stimulus objects at various angles and distances and observing the child's movements.

Materials

Stimulus items and materials for measurement have been previously described. (Refer to Reach in the Sidelying Position). In addition, a prone stander or standing table, straps, and a tray are needed to assist the child in maintaining the position.

Observation Setting

The two observation settings suggested for the measurement of reach have been previously described. (Refer to Reach in the Sidelying Position.)

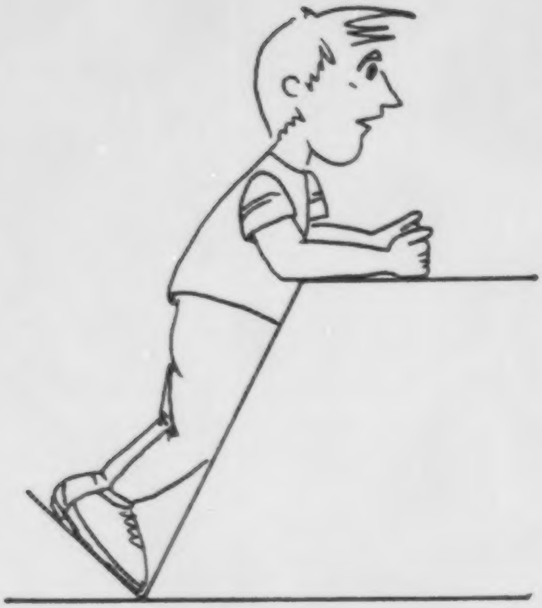
Positioning of the Child

Assessing reaching with a child who stands independently may be inappropriate. However, a child who requires support to stand may best be positioned in a standing table (prone stander) in order to assess his/her reaching skills. An appropriate standing device gives support to maintain an upright or slightly inclined forward angle with the following features: straight trunk, legs slightly apart (6-12 inches), knees slightly bent, and feet flat (See Figure 10). Straps at the trunk, hips, and legs may be needed to hold the child in the adaptive equipment. A tray or table is positioned at elbow height.

Figure 10

Child in Appropriate

Standing Position



FM(R)37

FINE MOTOR

Procedures for Measuring
Grasp

by

Teresa Wright Neese[1] and Marilyn Mulligan

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[1] The procedures reported in this study were taken from a master's thesis research conducted by Teresa Wright Neese submitted to the Department of Special Education at the University of Kansas, 1980.

Measuring Grasp

Procedures for measuring the skill of grasp are described below. These procedures represent an improvement over previous procedures typically utilized in the measurement of grasp because of the further specification of different types of behaviors involved and clearer guidelines for the evaluation process.

The descriptors of the types of grasp have been expanded to include the digits involved in the grasp and a differentiation between the use of the palm and tips of the hand.

The evaluation setting is extensively specified. The procedures suggest that each child be evaluated in those positions most appropriate to his or her current level of functioning. Positions described are sitting, standing, and sidelying. The setting of the evaluation is in either a structured or unstructured environment with materials attractive to the child yet of a specified size. The trials for the actual assessment of the response are delineated by the cues, presentation of the stimulus items, and the determination of the end of the trial. Finally, the actual criteria for assessing if a response did or did not occur are given for each behavior analyzed in the grasp response.

Grasp in the Sitting Position

The following procedures are designed to measure the use of fingers, the right or left hand, and the palm or the fingertips in the grasp of an individual in the sitting position. Additional considerations are made if no grasp occurs. Two methods of measuring grasp are delineated: (1) measurement of voluntary grasp and (2) measurement of reflexive grasp.

Materials

Measurement instruments. A data sheet (Figure 1), cumulative stopwatch, pencil, and optional clipboard are necessary to record the grasp data.

Positioning equipment. Materials necessary to maintain and support the child in the sitting position may vary. A range of equipment is available and appropriate for children who do not sit independently, i.e., travel chair, wheel chair, adaptive chair, infant seat, high chair, etc. A tray or other working surface at elbow height is needed for placement of the stimulus items.

Stimulus items. Preferred items in the shape of a ring, cylinder, cube, and pellet are suggested as stimulus items. These items can be identified by parental report or by presenting a variety of objects to the child and recording the response. A child may demonstrate preference for an object by looking at it for an extended period of time, reaching for it, etc. There are typically a variety of items in the classroom of the required size and shape. A cylinder shape, approximately 3.5 inches by .5 inches, is suggested. A bristle block toy fits these size dimensions with the additional advantages that it doesn't roll across the table or stimulus surface, provides tactile feedback from the ridges in the toy, and it comes in many bright colors. Any ring approximately three inches in diameter with the mass of the ring approximately .25 inches in diameter is appropriate. The recommended size for the cube is one square inch. The cube may be any color, texture, or material. Blocks with alphabet letters, numbers, animals, etc. are suggested if they are attractive and motivating to the individual child. The pellet should be approximately .25 inches in diameter. It is suggested

Figure 1

Data Sheet for the Measurement of Grasp

Figure 1

Grasp Pattern Data Sheet

Subject ________________ Examiner ________________

Date ________________ Observer ________________

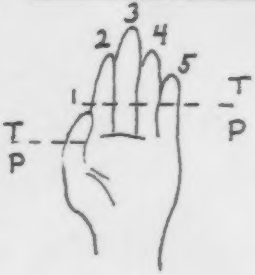
Body Position ____________ Reliability ____________

Structured ☐ Unstructured ☐

1 - Thumb
2 - Index
3 - Middle
4 - Ring
5 - Little

T-Tips

P - Palm



Stimulus	Left Right	1	2	3	4	5	P or T
Cylinder 1							
Cylinder 2							
Cylinder 3							
Ring 1							
Ring 2							
Ring 3							
Cube 1							
Cube 2							
Cube 3							
Pellet 1							
Pellet 2							
Pellet 3							

that the pellet be consumable because nonconsumable pellets, such as a button, pebble, etc., are difficult to retrieve from a child's mouth.

The following are some examples of commonly reinforcing objects to be grasped which are consumable. A tootsie roll, carrot, celery, or piece of fruit may be substituted for the cylinder shape. A consumable ring could be a small doughnut, an onion ring, or a cut piece of fruit such as an orange, etc. Carmel cube candies, cubed fruit, etc. are suggested for the cube object. A raisen, M & M's, a sugar tart, or small pieces of fruit are recommended for the pellet.

Observation Settings

The voluntary and reflexive grasp response may be observed in both structured and unstructured settings. Whichever is used, the child should be visually and socially alert, compliant, and comfortable. The optimum times for assessment are 1/2 to 1 hour before or after a feeding or nap time. Discontinue the session if the child becomes disruptive as a result of tantrums, seizures, sleep, etc.

Structured observation. These observations should take place when the assessment of grasp is the goal of the session, no other training or activities should be occurring. The child may be in the home or school setting and other children may or may not be present. In either environment, the child is faced away from any extraneous distractors.

Unstructured observation. These observations may take place during activities that occur daily. Grasp behavior may be a component of the activity, but is not the training focus. Example activities are eating, socialization, home activities, free time, language, or other routine activities.

Positioning the Child

The examiner should only utilize the sitting position if it is a functional or frequently used position by the child. The child should be able to tolerate the position for approximately twenty to thirty minutes.

Place the child in a familiar chair suited for his or her body size. Position the feet flat on a hard surface or on the floor. Flex the hips, knees, and ankles to approximately 90 degrees. Place the trunk and head in good anatomical alignment with the hips (see Figure 2).

Position the stimulus presentation surface (table top, tray, board, etc.) in front of the child and adjust it so the child's forearms rest comfortably on it, with the elbows flexed (bent) to approximately 90 degrees. Place pillows, posey belts, straps, etc. to maintain the child adequately in supported sitting.

Description of the Behavior to be Measured

The measures of grasp are made by an occurrence recording of the use of the parts of the hand and the fingers involved in the grasp response. The child is considered to be engaged in the grasp response the moment the object is secured in one hand and no longer supported by any other surface.

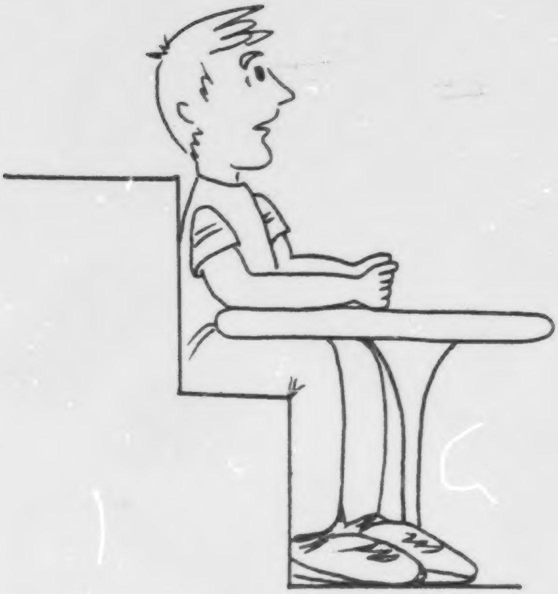
Left-Right. Indicates the first or only hand grasping the object the moment it is picked up or removed from the stimulus presentation surface.

Digit 1. Any portion of the thumb is touching the stimulus object the moment it is picked up or removed from the stimulus surface.

Digit 2. Any portion of the index finger is touching the stimulus object the moment it is picked up or removed from the stimulus surface.

Figure 2

Child in Appropriate Sitting Position



Digit 3. Any portion of the middle finger is touching the stimulus object the moment it is picked up or removed from the stimulus surface.

Digit 4. Any portion of the ring finger is touching the stimulus object the moment it is picked up or removed from the stimulus surface.

Digit 5. Any portion of the little finger is touching the stimulus object the moment it is picked up or removed from the stimulus surface.

P or T. "P" or palm is recorded if any part of the hand from below the middle joint of each digit 2, 3, 4, and 5, and below the end joint of digit 1 contacts the stimulus the moment it is picked up or removed from the stimulus surface. The palm area includes that part of the hand that joins the wrist at the natural anatomical wrist joint line.

"T" or tips is recorded if any part of the hand above the middle joint of each digit 2, 3, 4, and 5, and above the end joint of digit 1 contacts the stimulus object the moment it is picked up or removed from the stimulus surface. The tip area encompasses the front and back of the fingers to the end of each digit.

Procedures for Measurement

Two different measurement procedures are provided, one for voluntary grasp and one for reflexive grasp. To determine which measurement precedure to use (method A or method B described below), observe the child for one minute per object (cylinder, ring, cube, or pellet). Method A is used if the child grasps the objects independently or grasps some of the objects, but only touches others. Method B is used if the child touches the object but does not grasp, or does not touch any of the objects.

Position the stimulus object within one to two inches of the thumb side (radial side) of the child's hand as it is resting on the stimulus presentation surface. Gain the child's attention by passing the object through the child's visual field, tapping the stimulus presentation surface with the object, or tactually stimulating the child's hand with the object, i.e., taking the child's hand and touching it to the object and replace the object in the appropriate position on the stimulus presentation surface.

Method A. After gaining the child's attention and placing the object on the stimulus presentation surface, allow five seconds for the child to grasp the object.

1. If the child does not grasp the object within five seconds, the examiner may "advertise" the stimulus by repeating the visual, auditory or tactile cues.

2. Allow another five seconds to pass. If the child does not grasp the item record "no grasp" on the data sheet (Figure 1) across the row appropriate for the stimulus item and trial.

3. If the child's reach is inaccurate and the stimulus object is knocked around the stimulus presentation surface during the first five seconds, the examiner can stabilize or hold down the stimulus object for the second, five second period. The examiner writes "stabilized" on the data sheet while recording the descriptors of the grasp. If the child still cannot grasp the stimulus object in the second five seconds, the examiner records "no grasp".

4. If the child grasps the object, record the grasp descriptors for the first moment the stimulus object is removed from the stimulus presentation

surface. Note whether or not the child is using the right or left hand, the fingers involved, and whether the tips or the palm of the hand are used by the child to retain the grasped object. The examiner records this data by checking each descriptor horizontally per trial in the corresponding columns on the data sheet for each stimulus item. Only the fingers touching the grasped object are scored. If any part of the palm is touching the object, "P" is scored in the appropriate data sheet column. If the fingertips alone are touching the object, "T" is marked in the appropriate data sheet column. "L" or "R" is marked in the appropriate column to indicate either the left or right hand used in the grasp.

5. The examiner is free to repeat trials that occur too quickly to be reliably observed and to alternate trials across all stimulus presentation items.

Method B. This assessment procedure is for a child who has not demonstrated a voluntary grasp. The assessment of a reflexive grasp, by definition, involves the use of the palm. In the column marked "P" or "T", the type of grasp being elicited is recorded. Three types of reflexive grasp are tested: inside (radial) instinctive, outside (ulnar) instinctive, and middle (palmar) instinctive grasps.

A minimum of six trials is suggested for both the right and left hands, with two trials of each reflexive grasp. The examiner is encouraged to alternate radial, ulnar, and palmar trials. The cylinder and the cube are recommended as the tactile stimulus used to evoke the grasp reflexes, however other stimulus objects can be substituted.

1. To test for the presence of a radial instinctive grasp, apply pressure with the cylinder or the cube (tactile stimulation) midway

on the forearm. Maintain pressure while moving the object down to the inside or radial part of the arm to the end of the thumb. No more than three presentations of tactile stimulation is recommended for each trial. More than three presentations would desensitize the child to the stimulation.

If radial instinctive grasp is present, the child's hand gropes towards the stimulus object and "holds" the object briefly, for at least one second. There must be a definite closing action of the fingers around the object. Record the fingers involved in the grasp for the appropriate stimulus column on the data sheet (Figure 1). If the radial grasp is not present, if the child has not made any move towards the stimulus object, record "no grasp" on the trial line.

2. For assessment of ulnar instinctive grasp, much of the same procedure is utilized as radial instinctive grasp. However, the stimulus is presented to the outside part of the hand and down to the little finger. Apply pressure with the stimulus object to the ulnar or little finger side of the arm. Maintain contact while moving the object down to the end of the little finger. No more than three tactile stimulations are recommended for each trial.

If ulnar instinctive grasp is present, the hand will grope towards the stimulus and "hold" the object for at least one second. There must be a definite closing action of the child's fingers on the object. Record the fingers involved in the grasp for the appropriate stimulus column on the data sheet (Figure 1). If the ulnar grasp is not present, record "no grasp" on the trial line.

3. For assessment of the palmar instinctive grasp, begin the tactile stimulation with the stimulus object on the palm side of the arm midway down the child's arm. Maintain continual contact while moving the stimulus object to the palm of the hand and then exert moderate pressure on the palm of the hand with the object.

If palmar reflexive grasp is present the hand will close around the object briefly, for at least one second. Record the fingers involved in the grasp for the appropriate stimulus column on the data sheet (Figure 1). If the palmar grasp is not present, record "no grasp" on the trial line.

Periodic probes are suggested to determine when to make the transition from Method B to Method A. To implement a probe, refer to the pre-assessment procedure at the beginning of this section.

Tabulating the Data

Performance data is tabulated in terms of the percent use of separate digits, the tips of the hands, and the right or left hand across each stimulus item. This data is graphically represented for each body position in which the child is assessed.

Each child is assessed over four sessions, totaling twelve trials per stimulus item. The percent performance is calculated by dividing the number of occurrences for each digit, the tips, and the right or left hand by the total number of possible occurrences, twelve. The resulting graph represents the percent performance for each stimulus item for both the right and left hand in each body position.

Grasp in the Standing Position

The following procedures are designed to measure the use of fingers, right or left hand, and the palm or finger tips in the grasp response of an individual in the standing position.

Materials

The stimulus items and measurement materials have been previously described. (Refer to Grasp in the Standing Position).

Additional materials needed to support or maintain the individual in the standing position may be needed. These could include a standing frame, prone board or stander, table at elbow height, etc.

Observation Settings

The two observation settings suggested for the measurement of grasp have been previously discussed. (Refer to Grasp in the Sitting Position.)

Positioning the Child

Place the child in a standing position in a prone stander or standing frame, etc. An appropriate device gives support as needed to maintain an upright or slightly inclined forward angle (within 15 degrees of an upright position) with the following features: straight trunk, legs slightly apart, knees slightly bent, and feet flat. Straps secured around the trunk, hips, and legs may be needed to hold the child in place (see Figure 3).

Description of the Behavior to be Measured

The description of the behavior to be measured have been previously described. (Refer to Grasp in the Sitting Position.)

Grasp in the Sidelying Position

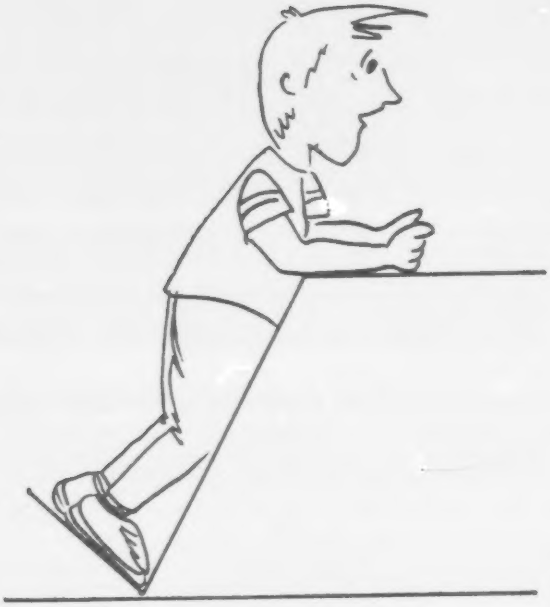
The following procedures are designed to measure the use of digits, the right or left hand, and the palm or tips in the grasp performance of an individual in the sidelying position.

Materials

The stimulus items and measurement materials have been previously described. (Refer to Grasp in the Sitting Position.)

Figure 3

Child in Appropriate Standing Position



Additional materials needed to support or maintain the child in the sidelying position may be needed. These could include pillows, sandbags, bolsters, blankets, mats, etc.

Observational Settings

The two observation settings suggested for the measurement of grasp have been previously described. (Refer to Grasp in the Sitting Position.)

Positioning the Child

Place the child on either the right or left side on the floor or mat. A child who is more physically involved or limited on one side than on another is placed so that his or her best arm is on the top. In a sidelying position, the child's head is bent slightly forward (flexed), the hips and knees are slightly bent (flexed), and the shoulders are rolled forward (see Figure 4). If the child's muscle tone is more than normal (hypertonic or spastic), he/she should be relaxed prior to positioning so the above described position is easily elicited and maintained.

Sandbags may be used in quantities and locations needed to maintain the position: behind the child's buttocks, shoulders, thighs, head, and in front of the stomach. Remove the child from the position when there are indicators of fatigue such as irritability, drowsiness, or a decrease in head control.

Description of the Behaviors to be Measured

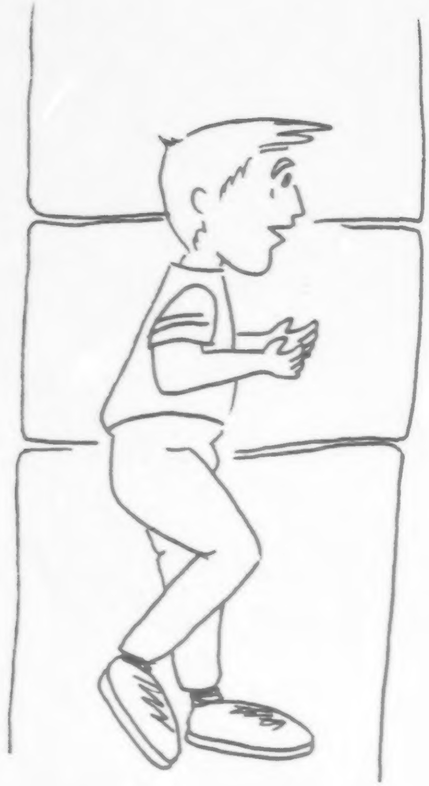
The description of the behaviors to be measured have been previously described. (Refer to Grasp in the Sitting Position.)

Procedures for Measurement

Procedures for measurement have been previously described. (Refer to Grasp in the Sitting Position).

Figure 4

Child in Appropriate Sidelying Position



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Tabulating the Data

Procedures for tabulating the data have been previously described. (Refer to Grasp in the Sitting Position.)

FINE MOTOR

Procedures for Measuring Release

by

Aileen Cronan[1] and Marilyn Mulligan

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[1] The procedures reported in this study were taken from a master's thesis research conducted by Aileen Cronan submitted to the Department of Special Education at the University of Kansas, 1980.

Measuring Release

Procedures for measuring the fine motor skill of release are described below. These are an improvement over previous procedures typically utilized for the assessment of release because of the further specification of what behaviors are involved in a release and clearer guidelines for the evaluation process.

The descriptors of release usually identified have been expanded from the typical items such as "release into a container" or "drops object to pick up a third" to include the digits and part of the hand involved in the release, whether the arm or hand is supported during the release, and if the release is direct. Occurrence data is taken on each component of the release response rather than just on the outcome of the response.

The evaluation situation is extensively specified. It is suggested that each child be evaluated in at least two positions appropriate to his or her current level of functioning. Possible positions are supported or unsupported sitting, sidelying, or standing. The setting of the evaluation is described as either in a structured or unstructured situation with materials of specified size or with items the child commonly interacts with. The trials for the actual assessment of release are delineated by the cues, where to present the stimulus items, and how to determine the end of a trial. Finally, the actual criteria for assessing if a response did or did not occur are given for each behavior involved in a release.

Release in the Sitting Position

These procedures are designed to measure the topography of a release in the sitting or supported sitting positions. Descriptors identified are the fingers and portion of the hand used, whether the arm or wrist is supported, and if the release is or is not into a container.

Materials

Materials include a data sheet (Figure 1), pencil, stop watch, and objects for release. Four different sized objects are suggested: a wooden cylinder 1 cm. in diameter and 8.3 cm. long, a 2.5 cm. wooden cube, a ball 10 cm. in circumference, a wooden pellet 4 cm. in circumference, and a plastic container with approximately a 38 cm. circumference and a 3 cm. depth. Should the child attempt to ingest the 10 cm. ball and/or the 4 cm. pellet, the examiner may substitute a ball 14 cm. in circumference and a sugar pellet with a 1.5 cm. diameter. Talcum powder may be used when necessary to prevent materials from adhering to the child's hand during release efforts. Highly favored objects, toys, or food items preferred by the child are sometimes needed as distractors to precipitate a release.

Appropriate furnishings for a stable sitting position may include a regular table or an adapted chair with a tray.

Observation Settings

Measures of release can be made in both a structured and an unstructured setting.

Structured setting. Each child is evaluated during a separate session structured specifically to evaluate the release response. The child is positioned and materials listed on the data sheet (Figure 1) are systematically presented. The examiner and optional second observer position themselves at a good vantage point, to view the release response of the child. Variations in a child's individual movement patterns which might obscure observers' views are considered when selecting these

Figure 1

Data Sheet for the Measurement of Release.

Figure 1

Release Data Sheet

Subject ______________________ Examiner ________________

Date _________________________ Observer ____________________

Body Position _________________ Reliability __________________

Structured Unstructured

Fingers Used:
1 - Thumb
2 - Index
3 - Middle
4 - Ring

S - Supported Arm
U - Unsupported Arm
A - Against Surface or Hand
N - No Surface or Hand

Discriptors:
R - Right Hand
L - Left Hand
P - Release from Palm
T - Release from Finger Tips

C - Into Container
O - No Container
NO - No Release

Stimulus	Fingers Used 1 2 3 4 5	R or L	Descriptors P or T S or U A or N C or O	No	Reliability
Cylinder					
Cylinder					
Cylinder					
Ball					
Ball					
Ball					
Cube					
Cube					
Cube					
Pellet					
Pellet					
Pellet					

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vantage positions. Observers score the child's release patterns using the data sheet (Figure 1).

Unstructured settings. Unstructured observations may take place during regularly occurring classroom or home activities when the child is placed in an appropriate performance position for play or instruction. Data is taken as the child manipulates training objects, toys, and utensils. The examiner scores the child's release patterns using the data sheet (Figure 1), making notes in the materials column as to the type of object released.

Positioning the Child

Place the child in any sitting aparatus which allows free movement of the arms. Depending on the physical involvement, varying amounts of support may be needed. The most appropriate position provides upright sitting with the body in good alignment, the hips and knees bent at 90 degree angles, and the feet flat on a supporting surface (Figure 2). If the child's muscle tone is more than normal (hypertonic or spastic), utilize relaxation techniques prior to positioning so that the above described position is easily elicited and maintained. Place a working surface at elbow height.

The child's tolerance for the sitting position may range from a few minutes to a maximum of twenty minutes. Typical indicators of fatigue such as decrease in head control, irritability, drowsiness, etc., should be monitored. Discontinue the session when they occur.

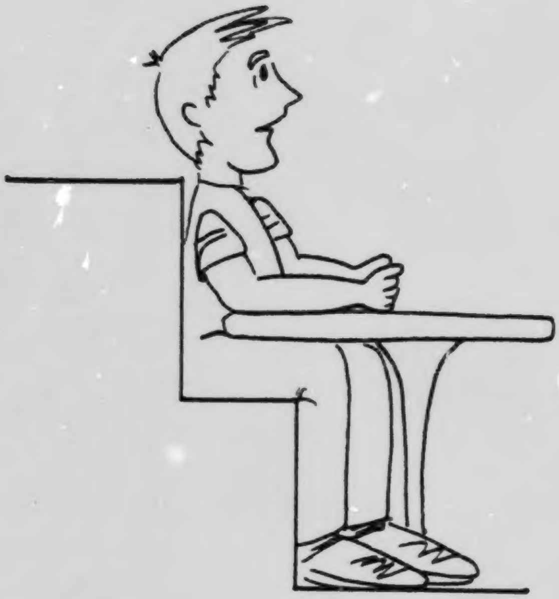
Description of the Behavior to be Measured

The examiner measures release in supported sitting across the following objects: rod, ball, cube, and pellet (See Materials). A release of these objects is identified when an object, retained for

Figure 2

Child in Appropriate

Sitting Position



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at least two seconds in one hand, no longer has contact with that hand or fingers. For an object to be considered retained, it must be free of a resting surface for the entire two seconds. Release is considered to only occur from one hand. Transfers are not considered releases. For measurement of the transfer response, refer to the procedures described by Mellard and Mulligan in Transfer in the Sitting Position, FM(T) 1.

The following information is observed and recorded for each trial across materials:

1. occurrence of release
2. use of the right or left hand
3. the digits involved at the moment of release
4. the part of the hand involved at the moment of release
5. whether the forearm is supported during release
6. whether the release is against a surface
7. whether the release is into a container.

When the child does not have a voluntary grasp, the examiner places the test item in the child's dominant hand and elicits a grasp. In this case, a notation is made that the selection of right or left hand was not voluntary. Refer to procedures for the assessment of the grasp response as described by Neese and Mulligan in Grasp in the Sitting Position, FM(R) 1.

Behavior Definitions

The following terms and definitions are used to describe the parts of the hand and arm involved in a release. Each descriptor is defined on the data sheet (Figure 1).

Fingers used, 1-5. Digits 1-5 refer to the thumb (1) through the little finger (5).

Palm. Refers to the portion of the hand between the middle knuckles and the lower edge of the heel of the hand.

Tips. Refers to the portion of the digit above the middle knuckles of the fingers.

Supported arm. When the forearm is resting on any surface at any point from the elbow to the wrist. An arm is also considered supported when gravity has been eliminated by an observer suspending the arm at any point from the elbow to the wrist (Figure 3).

Unsupported arm. When the arm is not in contact with any surface or is not supported from the elbow to the wrist.

Against a surface. When the test object is in contact with any surface (table top, container, portion of the child's or an observer's body) at the moment of release.

No surface. When the test object is free of any surface, other than the child's hand at the moment of release. The result is that the object drops onto a surface.

Procedures for Measurement

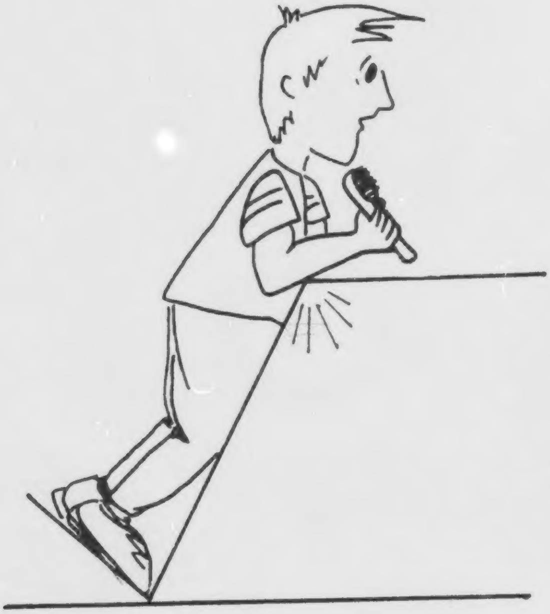
Each session consists of three trials, approximately thirty seconds in length, with each of the four test items; rod, ball, cube, and pellet. This totals twelve trials for each session.

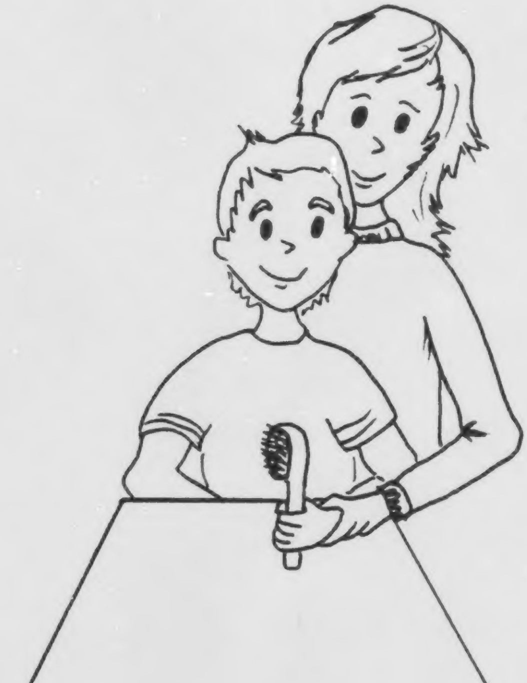
1. Place the test material on the table in the midline position before the child. Encourage him/her to pick up the object with a verbal cue such as, "Look", "Pick it up", "Take it", or by tapping the object on the surface.

Figure 3

Two Alternatives for Support

of the Forearm





2. If the child does not pick up the object, present the item to the subject in a midline position, approximately eight inches in front of his or her chest. If the child does not grasp the object, repeat the verbal cue.

3. In the event that physical priming of a grasp is necessary, place the test item in the child's dominant hand.

4. Place the container on the table in the midline position approximately eight inches before the child.

5. A trial begins when the child has maintained a grasp on an object for two seconds. (Refer to Description of Behaviors to be Measured).

6. Start the trial by tapping the container and giving the child a verbal cue such as "Put in."

7. If the child does not move to place the item in the container, present a palm up, open hand to the child and ask for the item with a prompt such as "Give."

8. If the child still does not release the object, present a highly preferred toy or object in an effort to elicit a release of the test item. If the child does not release the test item, taking the preferred item with the other hand, present an additional item in an effort to elicit a release.

9. If the child has difficulty raising his or her arm, eliminate gravity by gently supporting the forearm half way between the wrist and the elbow (Figure 3).

10. A trial ends the moment the child releases the test item or when 30 seconds elapses, whichever occurs first.

Each trial is scored separately on the data sheet (Figure 1). The trials are specified by the stimulus items listed under the column heading "Stimulus". Each object listed indicates the row on which the performance demonstrated during the release trial is to be recorded. The procedures for scoring the type of release for each trial are as follows:

Fingers used, 1-5. Recording which fingers are in contact with the test object at the moment of release is done by placing a check mark under the columns headed by the number of the fingers involved in the release. For example, if the thumb and the index finger are involved, the columns under 1 and 2 would be checked for the stimulus material being used.

R or L. Use of the right hand is scored in this column by recording an "R" on the data sheet when the object is released from the right hand. An "L" is scored when the object is released from the left hand.

P or T. Use of the palm or tip is scored in this column. A "P" is recorded on the data sheet when the test object is in contact with any portion of the hand between the middle knuckle of the hand and the lower edge of the heel of the hand at the moment of release. A "T" is recorded when the test object is only in contact with the area on the fingers above the middle knuckle at the moment of release.

S or U. The occurrence of support provided to the forearm is recorded in this column. An "S" is scored when the forearm is resting on top of any surface or when gravity has been eliminated by the examiner (Figure 3). A "U" is recorded when no portion of the arm, from the elbow to the wrist, is in contact with any surface.

A or N. When the object is supported during release, this column is scored. An "A" is recorded when the test object is in contact with any surface (table top, container, portion of the child's or examiner's body) at the moment of release. An "N" is recorded when the entire test object is free of any surface, other than the hands of the child, at the moment of release.

C or O. Whether the release is direct is recorded in this column. A "C" is recorded when the test object is released into, or partially into, the test container. Items are counted as "C" if any part of the object is in the container or if the object falls, bounces, or rolls out after being released into the container. An "O" is recorded when the test item is released but does not initially contact the bottom of the container.

No. If no release occurs, a check is scored in this column. No release is defined by the hand remaining in contact with the object throughout the 30 second trial.

Discard trials when distractions or interruptions occur in the testing area, or when the child's behavior is incompatible with a trial (i.e. crying, seizure activity, extreme fatigue, loss of attention to task.)

Tabulating the Data

Reliability. The actual release performance is represented by the percent of times the child displays each of the items measured with each material. The score is calculated by dividing the number of times the behavior occurs in each session by the number of trials and multiplying by 100. Percent of occurrence is calculated for each behavior with each material across four sessions in each position. Performance data is summarized in graphic form with a separate bar graph for each material in each position. The percentage of times the skill occurs appears on the verticle axis. Preferred behaviors measured with each material appear on the horizontal axis.

Release in the Sidelying Position

Materials

Materials required for the measurement of release have been previously described (Refer to Release in the Sitting Position). Other materials may include bolsters, pillows, etc. required to assist or maintain the child in the sidelying position.

Observation Settings

The two observation settings suggested for the measurement of release have been previously described. (Refer to Release in the Sitting Position.)

Positioning the Child

Place the child on either the right or the left side on the floor or mat. A child who is more physically involved or limited on one side more than the other (e.g., spastic hemiparesis) is placed so that the best arm is on the top. When in the sidelying position, the child's head is bent slightly forward (flexed), the hips and knees are slightly bent (flexed), and the shoulders are slightly rolled forward (shoulder protraction)(Figure 4). As in sitting, if the child's muscle tone is more than normal (hypertonic or spastic), utilize relaxation techniques prior to positioning so that the above described position is easily elicited and maintained. Maintenance in the position is either independent or with support. The examiner can provide support by sitting behind the child on the floor and using his/her own body parts to maintain the child in the proper position. Sandbags and bolsters may also be used in quantities and locations needed (i.e., behind the child's buttocks, shoulders, thighs, knees, head, and in front of the child's stomach).

Description of the Behavior to be Measured

The description of the behaviors to be measured have been previously described. (Refer to Release in the Sitting Position.)

Procedures for Measurement

The specific procedures for each trial have been previously described. (Refer to Release in the Sitting Position.) Positioning of the stimulus object is altered as a result of the sidelying position. Place the items on the floor or mat approximately eight inches in front of the child's chest. Gain the child's attention and measure performance in the same manner as when assessing in the sitting position.

Tabulating the Data

Procedures for tabulating the data have been previously described. (Refer to Release in the Sitting Position.)

Release in the Standing Position

Materials

Materials required for the measurement of release have been previously described. (Refer to Release in the Sitting Position.) Other materials may include a table, standing frames, prone board, etc. used to assist or maintain the child in the standing position.

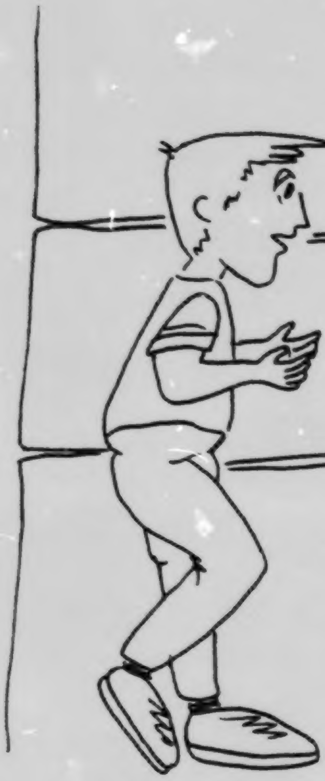
Observation Settings

The two observation settings suggested for the measurement of release have been previously described. (Refer to Release in the Sitting Position.)

Figure 4

Child in Appropriate Sidelying

Position



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Positioning the Child

Place the child in a free standing position beside a table or supporting surface at approximately elbow height. A standing device, such as a prone stander, may also be appropriate to maintain the child in an upright or at a slightly inclined forward angle. The position includes a straight trunk, legs slightly apart, knees slightly bent, and feet flat. Straps at the trunk, hips, and legs may be needed to assist the child in maintaining this position (Figure 5). A tray or table can be positioned at elbow height.

Description of the Behavior to be Measured

The description of the behavior to be measured have been previously described. (Refer to Release in the Sitting Position.)

Procedures for Measurement

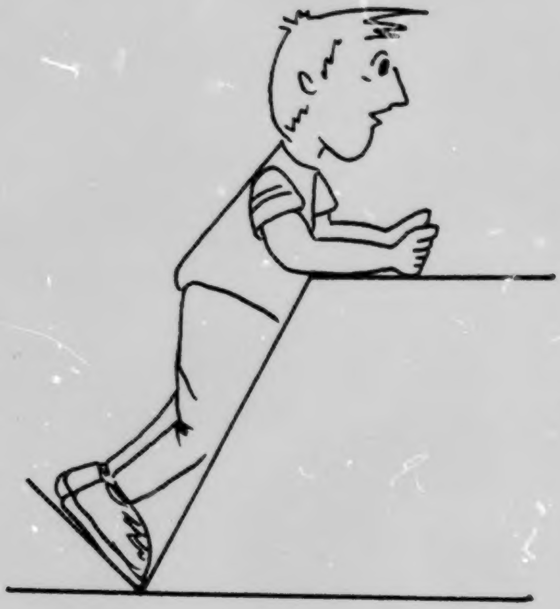
The specific procedures for each trial have been previously described. (Refer to Release in the Sitting Position.)

Tabulating the Data

Procedures for tabulating the data have been previously described. (Refer to Release in the Sitting Position.)

Figure 5

Child in Appropriate
Standing Position



FINE MOTOR

Procedures for Measuring
Transfer

by

Ellen Mellard[1] and Marilyn Mulligan

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[1] The procedures reported in this study were taken from a master's thesis research conducted by Ellen Mellard submitted to the Department of Special Education at the University of Kansas, 1980.

Measuring Transfer Skills

Two skills critical in the development of a transfer response are identified as a result of a review of standardized and non-standardized assessment tools. These skills are a bilateral reach and a transfer of an object from one hand to the other. In the developmental spectrum to one year, bilateral reach is considered to be at the lower end of the two handed skill sequence with transfer at the higher end. For emerging bilateral reach and low level midline skills refer to Procedures for Measuring Reach, by Proctor and Mulligan, (FM1). They developed an assessment of reach for severely, multiply handicapped children. In addition to other behaviors, this assessment measures reach at two different distances in midline, while describing duration, topography, and handedness.

Procedures for measuring the skill of transfer are descirbed below. These procedures represent an improvement over previous precedures typically utilized for the assessment of transfer because of the further specification of different types of behaviors involved, the use of latency as an indicator of the maturity of the response, and clearer guidelines for the evaluation process.

The descriptors of a simple occurrence of "transfer" have been expanded to include different types of manipulation that may result in a functional transfer, the location of the object during manipulation or transfer, the latency of the response, and the performance level as a function of object size and right or left presentation.

The evaluation setting is extensively specified. The procedures suggest that each child be evaluated in those positions most appropriate to his or her current level of functioning. Positions described are sitting, supine, and standing/supported standing. The setting of the evaluation is in either a structured or unstructured environment with materials attractive to the child yet of a specified size. The trials for the actual assessment of the response are delineated by the cues, presentation of the stimulus items, and the determination of the end of a trial. Finally, the actual criteria for assessing if a response did or did not occur are given for each behavior analyzed in the transfer response.

Transfer in the Sitting Position

The procedures described below measure the occurrence of various aspects of the transfer response in the sitting position. Descriptors identified to measure the emergence and utility of the transfer response are use of a third surface, location in relation to the body, direction, percent occurrence, and the effect of time.

Materials

Measurement instruments. A data sheet (Figure 1), stopwatch, pencil, and optional clipboard are necessary to record the transfer data.

Positioning equipment. Materials necessary to maintain and support the child in the sitting position may vary. A range of equipment is available and appropriate for children who do not sit independently, i.e. travel chair, wheel chair, adaptive chair, infant seat, high chair, etc.

Stimulus items. Preferred toys for each child are required. This information may be secured from a parent, teacher, or by observation of

Figure 1

Data Sheet for the Measurement of Transfer.

Figure 1

Transfer Data Sheet

Subject ______________________ Examiner ____________________

Date _________________________ Observer ____________________

Body Position _________________ Reliability __________________

Structured ☐ Unstructured ☐

Code:

T - Transfer

TS - Transfer using third surface

BH - Both hands on object

M - Object to mouth

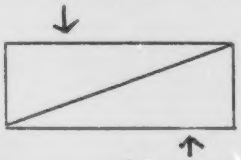
H - Hold in hand placed

D - Drop

C - Cross over

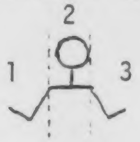
Scoring:

Score at end of first five seconds



Score at end of second five seconds

Location of Object:



	Presentation Position	Trials		
		1	2	3
Large Object	Left			
	Right			
Small Object	Left			
	Right			

what toys the child interacts with. Four large toys and four small toys should be selected. A large toy should fall roughly under the following dimensions: 6" x 8" x 4". Some examples of a large toy might be a doll, truck, large ring, or mirror. A small toy should fall roughly under the following dimensions: 4" x 2" x 2". Some examples of a small toy might be a rattle, cube, or squeeze toy. These items may have handles or other easily held parts. Edibles may also be used, especially to stimulate the transfer of an item already placed in the child's hand. Frequently the examiner may find it helpful to give the child the large or small toy which is to be transferred then immediately present an edible to the same side in which the child is holding the toy. The examiner should be careful to let the edible act as a reward for a transfer response and not as a reward for dropping the toy.

It is most important to have materials which the child is motivated to secure. Therefore, the examiner should frequently change the material which is presented to initate the transfer. For visually impaired children, the use of toys with an auditory or vibratory component is critical.

Observation Settings

The transfer response may be observed in two different types of settings. Whichever is used, the child should be visually and socially alert, compliant, and comfortable. The optimum times for assessment are 1/2 to 1 hour before or after feeding or nap time. Discontinue the session if there is a disruption as a result of the child tantruming, seizuring, sleeping, etc.

Structured setting. These observations take place in a classroom or in a home. Other students may or may not be present. The child is faced away from the main activity in the classroom so as to reduce the number of distractors. In the home, any room may be used that is free of an excessive number of distractors.

Unstructured setting. These observations may take place during free play or socialization time in the classroom or in the home. They may also occur during other routine activities during the day, i.e. language, fine motor.

The child is placed in a sitting or supported sitting position with a variety of toys placed within easy reach. No intervention should be attempted. An anecdotal system is kept on the number of items transferred, description of the items, the type of transfer, and the duration of observation.

Positioning the Child

The child is positioned in a chair adapted according to the child's needs. This chair should adequately support the child so that he/she is not having to balance his/her trunk. An upright position with hips, knees, and ankles at 90 degrees is most desirable (Figure 2). The child may also sit on the floor if trunk control is adequate.

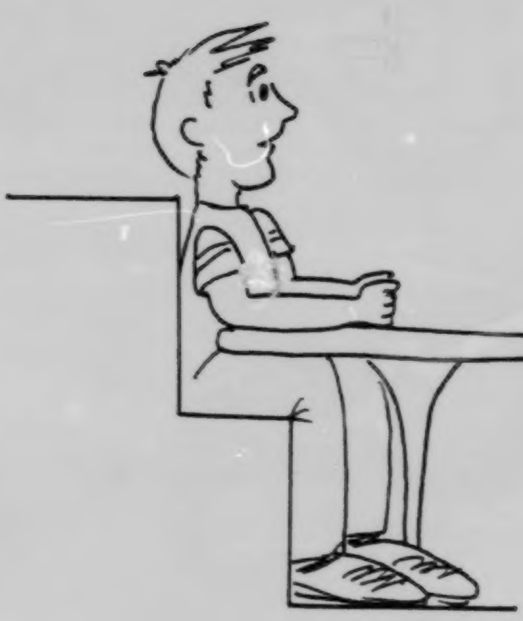
A lap board or table top at elbow height is secured only if the child is in need of this to maintain the sitting position.

The position should be maintained for the duration of the testing session although the child may be repositioned as often as necessary between trials.

Figure 2

Child in Appropriate

Sitting Position



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Description of the Behavior to be Measured

The measures of transfer are made by an occurrence recording of the transfer response, whether a third surface is used, and where the transfer is observed in relation to the child's body. The following coding system is used to measure the child's response to the stimulus presentations.

T - Transfer. The object is completely moved from one hand to the other without the object touching a third surface i.e. chest, table, mouth. The hand which initially held the stimulus item is no longer in contact with the item at the end of the transfer.

TS - Transfer using the 3rd surface. The object is completely moved from one hand to the other hand. During the transfer, or when both hands are in contact with the object, the object also contacts a third surface - mouth, chest, table top, etc.

BH - Both hands on object. Both of the child's hands remain in contact with the stimulus item until the end of the trial. A transfer does not occur.

M - Object to mouth. The object is in the child's mouth at the end of the trial. Either or both hands may or may not be in contact with the item. Transfer does not occur.

H - Hold in hand placed. At the end of the trial, the object is retained in the hand in which it was placed. A transfer does not occur.

D - Drop. The object is released or falls from the hand in which it was placed. Neither hand is in contact with the object at the end of the trial. A transfer does not occur.

C - Cross. When the second item is presented, the child crosses over with the opposite hand in order to receive it. For example, if the child is holding the toy in his right hand and the examiner presents the second stimulus on the child's right side, the child reaches across midline with the left hand. This score will usually occur within the first five-second time period. No transfer occurs.

Score at the end of the first and second five seconds. Each trial is divided into two five-second blocks. After the child receives the stimulus item, the teacher records the topography and the position of the stimulus item in relation to the child at the end of five seconds and ten seconds (the second five-second period).

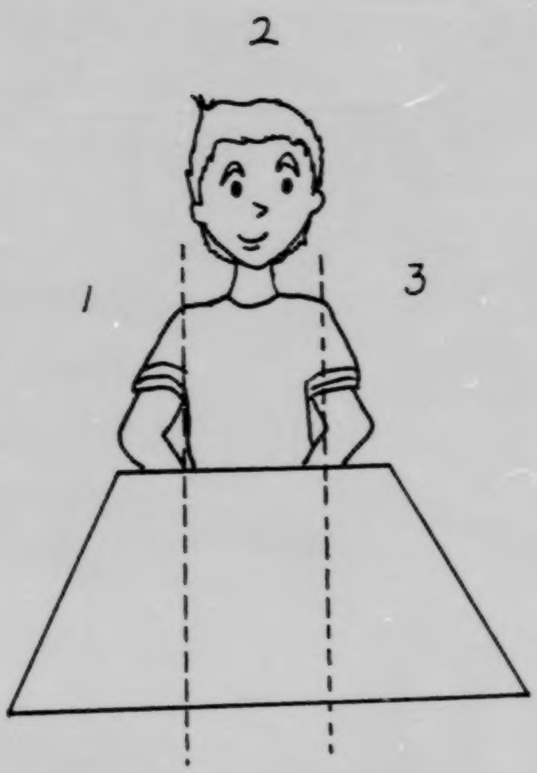
Location of the object. The area around the child is divided into three sections. Area 1 includes the area to the right of an imaginary verticle line running through the right shoulder, armpit, and down the right side of the trunk and hips. Area 2 includes the area between an imaginary vertical line running through the right shoulder, armpit, and down the right lateral side of the trunk and hips and an imaginary vertical line running through the left shoulder, armpit, and down the left lateral side of the trunk and hips. Area 3 includes the area to the left of an imaginary vertical line running through the left shoulder, armpit, and down the left lateral side of the trunk and hips (Figure 3).

Procedures for Measurement

Two procedures are described to elicit the transfer response from the child. In both procedures, a prime or put-through procedure is used before beginning the trials so that the child has been exposed to the desired response. This put-through procedure is conducted two times before the first trial.

Figure 3

Three Sections Around the Child's Body Designated as Stimulus Locations.



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When the child is positioned and ready to begin the trials, the examiner places the large object in the child's left hand with a verbal cue such as "put it in this hand" while simultaneously providing a tactile cue to the right hand. The examiner may also give another cue by placing his or her own hand on the child's right side and saying "put it in my hand". During the two primes, the examiner physically prompts the child to move the object from one hand to the other.

If using the second procedure, the examiner places the object in the child's left hand and offers another object on the child's left side (Figure 4). The situation is constructed to increase the probability that the child will transfer the first object from the left to the right hand in order to grasp the second object offered with the left hand. The procedure can also be conducted on the right side. During the two primes, the examiner physically prompts the child to move the object from one hand to the other.

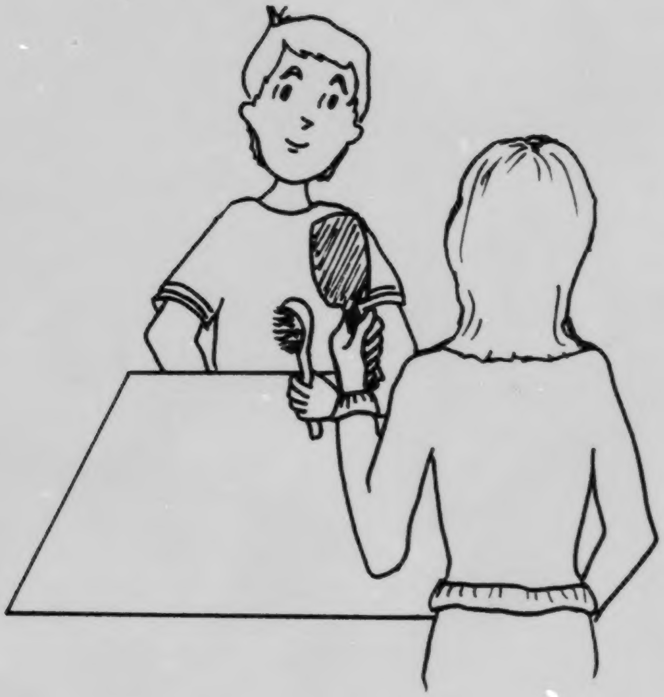
The procedure that works best for each child individually should be used. Emphasis is placed on eliciting the transfer response. The manner in which the examiner elicits this response remains flexible and can vary within a session.

If the examiner is using the first procedure, the trial begins when the examiner taps the child's opposite hand while simultaneously giving a verbal cue.

With the second procedure, the trial begins after the examiner places the first object to be transferred in the child's hand and the second stimulus is presented. The child's attention should be

Figure 4

Presentation of Two Objects on the Left Side to Elicit a Transfer Response.



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directed towards the second stimulus by either auditory, visual, or tactile cues. The examiner may tap the second stimulus on the child's hand or arm and then begin recording. The child may automatically transfer the object before given any additional cues. This would be considered a transfer under five seconds in duration.

The timing for the trials is best conducted by a third person with a stopwatch relating five second intervals to the examiner. Alternate methods of timing are self-counting or tape recordings with an auditory cue for the five and ten second intervals.

The ability to transfer is assessed with both large and small objects. The large object is presented to the left and to the right for a total of six trials. The same procedure is repeated for the small object. The actual sequence of presenting the stimulus item to the right or left and the selection of a small or large object is left to the teacher's discretion. A consistent pattern of presentation is suggested but not required.

Performance is scored at the end of the first and second five second intervals. The entire trial lasts ten seconds. At the end of the first five seconds, performance is scored in the upper half of the row for each trial according to the topography and location of the object. Performance is scored in the lower portion of the row at the end of the second five seconds. For example, a child who holds onto the item with both hands at the center of his/her body at the end of the first five seconds, but transfers in midline at or before the end of the second five seconds would be scored in this manner:

end of first	BH 2		end of second
five seconds		T2	five seconds

If a child successfully completes a transfer within the first five seconds, a "T" or "TS" is recorded along with the location in which the transfer occurred. The trial is ended with the transfer, no recording is made for the last five seconds. For example:

end of first	T2		end of second
five seconds		-	five seconds

If both hands remain on the object at the end of either five second period a "BH" and trisection recording is scored.

An "M" is scored if the child has the object touching or in his/her mouth at the end of five seconds without completing a transfer. When an "M" is scored, the area is usually scored as a "2". If the child is holding the object and the object is also in the child's mouth, an "M" is scored.

An "H" is scored if the child just retains the object in the hand in which the examiner placed it at the end of either the first or second five second periods. The location of the object, 1, 2, or 3, is also scored.

If the child drops the object during either five second time period, a "D" is recorded along with the location of the object, 1, 2, or 3 when it was released. If a "D" is scored in the first five seconds, the trial is stopped.

A "C" is scored if the child crosses over with the opposite hand in order to attain the second object. This will most likely occur during the first five seconds. If a cross does occur, the trial is stopped.

Tabulating the Data

Performance data is tabulated in terms of the percent occurrence of the type of transfer or manipulation and the position of the object across all trials. A total of twelve trials per object size is possible for each evaluation session. The actual percentage scores are calculated by dividing the number of occurrences of the type of transfer or manipulation and the position of each object at the end of each five second time period by the number of possible occurrences for object size. The percent data is graphed for each child for each body position used during the evaluation. Therefore, for each body position, four graphs are developed to represent the percent of 1) the type of transfer or manipulation and 2) the location of the object for the first and second intervals as they are a function of large and small objects presented to either the right or left side of the child.

Transfer in the Standing Position

The procedures described below, measure the types of transfer or manipulation, location of the object, and latency when the child is in the standing or supported standing position.

Materials

The stimulus items and measurement materials have been previously described. (Refer to Transfer in the Sitting Position.)

Additional materials necessary to support and maintain the child in a standing position may be needed. These could include a standing frame, prone board or stander, table at elbow height, etc.

Observation Settings

The two observation settings suggested for the measurement of transfer have been previously discussed. (Refer to Transfer in the Sitting Position.)

Positioning the Child

Place the child in a standing position in a prone stander or standing frame, etc. An appropriate device gives support as needed to maintain an upright or slightly inclined forward angle (within 15 degrees of an upright position) with the following features: straight trunk, legs slightly apart, knees slightly bent, and feet flat (Figure 5). Straps secured around the trunk, hips, and legs may be needed to hold the child in place.

Description of the Behavior to be Measured

The description of the behaviors to be measured have been previously discussed. (Refer to Transfer in the Sitting Position.)

Procedures for Measurement

The procedures for measurment have been previously described. (Refer to Transfer in the Sitting Position.)

Tabulating the Data

Procedures for tabulating the data have been previously described. (Refer to Transfer in the Sitting Position.)

Transfer in the Supine Position

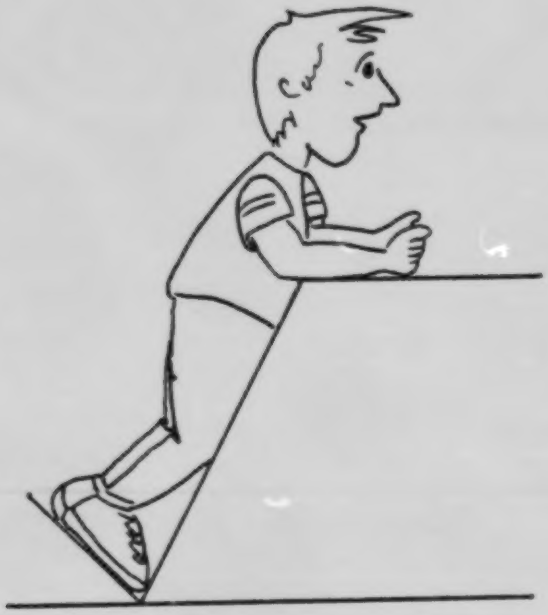
The procedures described below measure the type of the transfer response while the child is in the supine position.

Materials

The stimulus items and measurement materials have been previously described. (Refer to Transfer in the Sitting Position.)

Figure 5

Child in Appropriate Standing Position



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Materials necessary to maintain or support the child in the supine position may be needed. These could include pillows, sandbags, floor mat, or rug, etc.

Observation Setting

The two observation settings suggested for the measurement of transfer have been previously described. (Refer to Transfer in the Sitting Position.)

Positioning the Child

Place the child on his/her back on the mat or floor. Maintenance of this position may be achieved by placing sandbags, pillows, etc. on either side of the child's head and trunk as necessary. The examiner may also position his or her body to support the child by extending his or her legs down either side of the child's body. A small pillow can be placed under the child's head and at the base of the hips under the thighs in order to keep the child in a slightly flexed position (Figure 6).

Description of the Behavior to be Measured

The description of the behaviors to be measured have been previously discussed. (Refer to Transfer in the Sitting Position.)

Procedures for Measurement

The procedures for measurement have been previously described. (Refer to Transfer in the Sitting Position.)

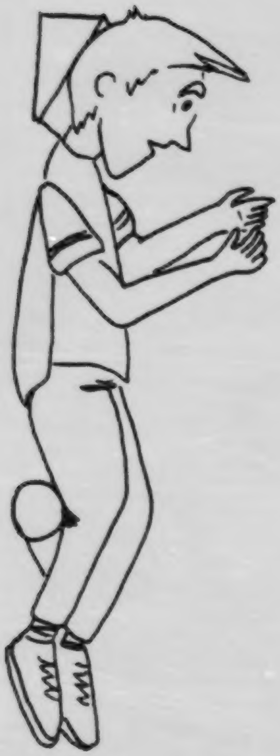
Tabulating the Data

Procedures for tabulating the data have been previously discussed. (Refer to Transfer in the Sitting Position.)

Figure 6

Child in Appropriate

Supine Position



FM(T)25

Review of Measurement Instruments and Procedures for Assessing Head Control: Implications for Quantitative Measurement

by
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[1] Preparation of this paper was partially supported by the Early Childhood Institute at the University of Kansas that is funded by the Bureau of Education for the Handicapped (USOE 300-77-0308).

This literature review is designed to survey and evaluate presently available information regarding the development of head erect behavior in handicapped and nonhandicapped children. The acquisition of head control is included in gross motor assessments that encompass skills developing during the first year of life. Head erect is one of the first gross motor skills that a normal infant develops. Head erect allows the child to view the environment and is a vital component of all other motor behaviors. Williams and Fox pointed out the importance of this skill in their Minimum Objective System for Pupils with Severe Handicaps (1977) by stating, "The ability to control the position of the head in relation to other body parts and to body position in space is developmentally the most basic controlled movement of the human body....it is the basis for all body movements." (page 13) Those children who fail to develop head erect behavior are limited in their ability to visually and tactually investigate the environment and therefore to learn from it. A more accurate assessment of the emergence and development of head erect behavior will provide precise quantification of present skill levels and sensitivity to incremental changes in performance. Such an assessment can be used to determine the effectiveness of teaching strategies and curriculum content.

The assessments reviewed provide a developmental progression by sequencing the evolution of this skill according to the position of the child (i.e., prone, supine, etc.). The discussion of standardized tests, nonstandardized assessments, and basic research will focus on testing conditions, stimulus descriptions, response definitions, and general measurement techniques.

Standardized Developmental Scales and Checklists

Instruments and developmental checklists were selected for review in this section because they included head erect behaviors appearing prior to 12 months of age, they sequenced the behaviors developmentally, and they were standardized. The information on head erect contained in these scales was organized according to the position of the child. The instruments reviewed included: The Bayley Motor Development Scale: (Bayley, 1969, The Denver Developmental Screening Test; (Frankenburg and Dodds, 1969); and the Developmental Diagnosis (Gesell and Amatruda, 1947).

All three scales provide limited information regarding the setting for the evaluation. Gesell and Amatruda (1947) suggest a conventional office containing a free, flat surface and a small test table. The setting for the evaluation and the physical structure of the room are not specified in the Denver Developmental Screening Test. The setting recommended for use with the Bayley Scale is a room large enough to contain an examining table, chairs, a crib, and a ten foot path in free floor space.

The position of the child is loosely described in each of the three evaluation tools and little information is provided concerning the position of the examiner. Gesell (1947) instructs the examiner to take a retired position at the baby's side. The child is placed in various positions but no information is provided regarding the amount of support supplied by the examiner or the placement of the examiner's hands.

The Bayley lists the child's position on the items relating to head erect but provides few specific directions for the examiner. The parent should be present and may present items under the direction of the examiner. Materials are used with only one of ten items relating to head erect. No motivation for head erect behavior is provided on the other nine items.

Directions to the examiner regarding the placement of materials need clarification. The examiner is instructed to hold an object within the child's view at the foot of the bed to motivate the child to lift his head and shoulders in an effort to sit. The position of the child in regard to the length of the bed is not indicated nor is the exact placement of the object specified.

The Denver evaluates head erect in three positions: prone, sitting, and pull to sit. No recommendations are provided regarding visual, auditory, or tactile stimulation to motivate head erect behavior on the Denver. The position of the child is specified but no directions concerning the examiner's behavior are stated. No materials are listed for the items concerning head erect. This omission could result in a situation where the examiner places the child in the appropriate position and waits for the behavior to occur without doing anything to elicit the behavior. It appears that the position itself is designed to serve as an antecednet event for the particular response. No time limit for the behavior to occur is stated, so trials cannot be differentiated.

Each of the three standardized scales uses occurrence/nonoccurrence data. No frequency or duration recordings are consistently used that could provide sensitivity to small changes in performance. The gross motor skills related to head erect on the Denver are: a) lifts head in prone; b) lifts head to 45° prone; c) lifts head to 90° prone; d) lifts chest with arm support in prone; e) head steady in sitting; and f) no head lag on pull to sit. The inclusion of number of degrees on lifts head in prone is an attempt to provide quantifiable data, but unfortunately this is an isolated attempt. There is no infomration on the development of head erect on pull to sit--it is either present or absent.

The first skill related to head erect in the prone position on the Bayley is "elevates self by arms". This example clearly shows the lack of sensitivity to incremental changes in performance and the omission of data allowing quantification of performance.

Gesell's Developmental Schedules (1947) leave many gaps in the provision of information relating to the acquisition of head erect. One graphic example of this lack of sinsitivity occurs in the two entries in the pull to sit position: "complete or marked head lag" (p. 31) at eight weeks and "no head lag" (p. 39) at 20 weeks. No scoring method is provided that allows the examiner to track the development of this skill.

Behavioral definitions are not specifically delineated on the Denver. The examiner is instructed to score a plus for "lifts head on stomach" if the child momentarily lifts his head off the table without being turned to either side. The examiner must interpret "momentarily" and determine if one second is adequate for a positive score and if a head lift that is part of a bouncing motion fits the criterion.

Gesell and Amatruda (1947) state that until eight weeks the child's head in the supported sitting position prevailingly sags forward but it may erect momentarily. This discription requires the examiner to determine what constitutes the erect position, the definition of supported sitting, and the definition of "momentarily." Another deficiency is found in the vague quantification methods provided in such a definition. As Cattell (1940) stated, "The directions for giving and scoring the Gesell tests were not sufficiently detailed and objective to insure comparable results from different examiners and they lend themselves to descriptive rather than to numerical ratings." (p. 19).

Quantifiable data are provided on several of the skills involving head erect on the on the Bayley. Duration of head erect is the criterion for scoring in the prone position. These same items are not operationally defined, however, since the criterion for scoring erect is not delineated.

These three standardized tools identify head erect behaviors in various positions. These instruments are unable to provide information regarding the development and refinement of head erect behavior because they are not sensitive to small changes in behavior nor do they consistently provide operationally defined behaviors that are quantificable.

Non-Standardized Assessment Instruments and Procedures

There are also many checklists available with training programs that are designed to serve both as indicators of present development and indicators of progress. Instruments that included items relating to head erect behavior occuring during the first year of life were selected for review. When applied to severely multiply handicapped children, these training program checklists fall short of their goals to indicate present development and progress. The increments of change are too large to reflect progress as a result of intervention. Also, behaviors are not generally operationally defined, nor are they quantifiable. Stimulus and response definitions are frequently incomplete and measurement techniques are not clearly defined. Little or no information is provided on the conditions for evaluation or the materials used.

Specific examples to support these conclusions will be cited from the Portage Project Checklist (Shearer, Billingsley, Frohman, Hilliard, Johnson, and Shearer, 1970), The Marshalltown Project Parent/Child/Home Stimulation (Keisler, Donahue, Montgomery, Roecker, and Smith, 1974), the Learning Accomplishment Profile (Sanford, 1975), the Developmental

Pinpoints (Cohen, Gross, and Haring, 1975), the Callier Azusa Scale (Stillman, 1977), The Pennsylvania Training Model (Somerton and Turner, 1975), and the Minimum Objective System for Pupils with Severe Handicaps (Williams and Fox, Note 2).

Three of the tools reviewed stated a general setting for the evaluation. The Portage is designed to be used in a home, classroom, or institution. The Marshalltown is recommended for use in the home. The Callier Azusa is to be used in the classroom after the child has been observed for two weeks. The contents of the room are not discussed. The Learning Accomplishment Profile recommends a familiar classroom for testing. None of the scales specifies the time of day or the state of the child for evaluation.

Materials used to evaluate head erect behavior are enumerated in two of the assessments reviewed. The Marshalltown utilizes toys that make noise. No substitutes are recommended for hearing impaired children. The placement of the materials is omitted so the examiner must decide where to position them and when to elicit their noisemaking properties. This omission could result in poor reliability scores because one examiner might sound the toy as a reinforcer for a response and another as a stimulus for a response.

Developmental Pinpoints requires only one object, a dangling ring, to assess head erect behaviors. It is used on one of ten items relating to head erect. This task is taken from Bayley and Gesell but no directives are provided on the position or movement of the ring. The examiner must consult the original sources to determine position of the child and that of the ring.

All of the scales use an occurrence/nonoccurrence measure but none of them dictate the length of time to wait for a response. Descriptive terms are often used to characterize the presence of a skill. For example, one item listed in the Developmental Pinpoints is, "holds head predominately erect when held sitting". On the Learning Accomplishment Profile the child is expected to lift head momentarily in prone at one month. At two months, the head position is predominately erect when held sitting and, at four months, the child shows no head lag when pulled to sit. No criteria are provided to aid the examiner in judging the presence of a "predominately" erect head.

Developmental Pinpoints does not universally provide quantifiable behaviors in the items concerning head erect. There are several attempts to meet this goal by including duration and angle data. In these cases, generally one or more intermediate steps are provided before the skill is considered completely developed in one position. These intermediate steps are often not clearly defined or differentiated. Four items relating to head erect in prone in the Developmental Pinpoints are: a) lifts head momentarily when prone; b) lifts head up when prone; c) lifts head and chest well up in midline using fore arms as support, legs straight out and buttocks flat when prone; and d) lifts head and chest well up supporting self on extended arms. No criteria are provided to allow the examiner to differentiate "a" from "b".

The Learning Accomplishment Profile contains items concerning head erect taken from Bayley, Gesell, and the Denver. It attempts to provide the examiner with more detailed information regarding competency scores on specific items. The appendix includes information on how to administer an item and suggests criteria for crediting a response. This information is intended to clarify the meaning of the tasks for teaching and assessment. The information provided does not succeed in fulfilling this intention. The criteria for scoring competency are not listed in concrete behavioral terms. The items require some judgment on the part of the examiner because the information is not presented in terms that have a universal meaning. The standard for scoring includes phrases like: momentarily lifts head, examiner feels child make postural adjustment, and holds head steadily erect. Each of these terms requires the examiner to subjectively define the criteria.

The Gross Motor Checklist of the Developmental Pinpoints contains many items relating to head erect behavicr but few of them are stated so clearly that two examiners would score a child's response in the same way. For example, one item is moving the head and eyes in every direction. It is difficult to discern what this means. The examiner must determine if the head and eyes should move simultaneously and if every direction includes up, down, right, left, diagonally, and circularly. The examiner must set some standard by which to judge the child's behavior so that he can determine how far the child must move his head in order for the response to be acceptable.

The Marshalltown Project is the most detailed criterion-referenced assessment reviewed. It provides a behavioral definition, verbal stimulus, measurement criteria, materials list, and behavioral strategies. It contains four items concerned with head erect behavior. The behavioral definitions are helpful in determining the criterion for scoring on two of the four items. The definitions for the other two items are not clearly stated so that there is some confusion on the part of the examiner concerning the intent of the definition. Consider the following behavioral definition for profile number 2.6: "While lying on stomach, child will lift head and shoulders at 90° angle, and look around". There is no indication whether the child must move his head to look around or if moving his eyes is sufficient. Objective criteria for scoring are absent and no information is given concerning the duration of the head lift.

Behavioral objectives and strategies on The Marshalltown Project are provided for each item as a sort of task analysis leading to performance of the specified behavior. This addition attempts to provide the examiner with some opportunities to document the development of a specific skill. Because these objectives and strategies are not presented in objective terms, they are subject to the same shortocomings as the behavioral definitions.

The Callier Azusa lists two entries regarding head control in the prone position: 1) turns head from side to side while on stomach; and 2) head control complete when lying on stomach and resting on open hands. These entries require occurrence/nonoccurrence data recording. They do not allow the examiner to observe the development or refinement of head erect in the prone position.

There are two entries involving the pull to sit position: 1) complete head lag when gently pulled to sitting position; and 2) when pulled to sitting, lifts head and assists. These examples clearly demonstrate the limitations of this tool to monitor the development of head erect behavior. The behaviors to be rated by the examiner are not stated in objective terms. The examiner must interpret the items listed and provide objective definitions for each. Complete head control in prone resting on open hands is an item that requires some interpretation.

Complete head control must be defined by the examiner in objective terms so that the child's behavior can be scored.

The Pennsylvania Training Model contains only two items concerned with head erect behavior. In the first, the child holds head up for three seconds with physical prompt to chin. In the second, the child maintains body weight on elbows for one minute. There are no items scoring head erect in other positions. These behaviors are observable and quantifiable but information is lacking regarding the examiner's behavior. The physical prompt to the child is not described so that one examiner might tap it while another might support it.

Specific measurement techniques and criteria for scoring are not consistently provided. The Portage Project lists this item: head control, face down position. The examiner must define this skill in behavioral terms in order to score the child on its acquisition. Omission of these specifications could affect the reliability of the evaluation tool since there are many instances where examiner interpretation is required.

The position of the child is not always provided. The Portage Project states that raising the head off the floor is a skill that occurs during the first year of life. The position of the child is not specified so the examiner must determine whether the child should be prone, supine, or sidelying. Even when the position of the child is specified, the examiner may not have enought information to position the child. The Learning Accomplishment Profile uses prone, supine, and supported sitting but the examiner is not told where to provide the support or how much support to give.

The examiner is not directed to provide visual or auditory stimuli to elicit head erect behavior and there is no specification regarding the amount of time to wait for a response.

The Minimum Objective System for Pupils with Severe Handicaps has four subskills listed under head erect: a) moves head freely 45° to each side; b) lifts head 90° in prone position; c) maintains head in line with spine when pulled from supine to sit; and d) holds head erect and steady when upright. These behviors are quantifiable and operationally defined. Essentially, the four behaviors allow the user to determine the presence of welldeveloped head control in prone, pull to sit, and sitting. However, these measures have no relevance for a child who has not yet completely developed these skills nor do they provide an evaluation tool for a teacher who is trying to improve a student's skills in these areas.

Research in the Development of Head Erect Behaviors

Research employing quantitative measurement procedures to monitor the acquisition of motor skills is represented by only a few studies in the literature. Whitney (1978) defined target behaviors and selected specific treatment procedures to attempt to achieve them. She used frequency and duration data to assess the effectiveness of intervention with multiply handicapped children ranging in age from five months to 20 years. Behavioral objectives that were clearly definable and measurable were chosen. Head control was defined only in the prone position to facilitate the ease and reliability of measurement. The child was positioned over the mother's knee. Duration data, beginning when the child's chin discontinued contact with the mother's knee and ending when the chin touched the mother's knee, were recorded five time each session.

Data were initially recorded daily but recordings were decreased to three times a week when a comparison of daily versus three times a week recordings indicated no statistical difference. Data were plotted on six-cycle semilog graph paper and analyzed in terms of slope to determine the effectiveness of treatment techniques. Observations and measurements were used to develop an individual curriculum for each child. Treatment programs that objectively produced positive changes in behavior were developed by constantly monitoring the target behaviors and changing the program accordingly. Using this method provided a rationale for each child's treatment and provided a means for identifying very small changes in motor behavior.

Roberts, Bundy, Mira, and Cairn, (1978) used continuous tracking of behavior, (i.e., measuring the frequency of the same behavior over time), to quantify changing behaviors. This strategy was used to measure infant development in the prone position: chin lifting, chest lifting, and creeping, with two normal infants, A horizontal line, drawn on tape placed on each infant's chest midway between the nipples, served as a recording cue to observers. Head constrol was measured in prone with two entries: chin lift and chest lift. The latter was scored if the child raised high enough for the examiner to see the line on the tape. Behaviors were scored on an event recorder. It provided both frequency and duration information. This method was reported by the authors to be sensitive to behavioral change in infancy and, in addition, to detect changes in the course of development at the time the changes were occurring.

A Developmental Sequence for Head Erect: Implications for Quantitative Measurement

Information on head control was compiled from all the standardized and nonstandardized assessment tools reviewed in this paper and categorized according to the position of the child. Figure 1 shows the behaviors contained in the standardized and nonstandardized assessment tools reviewed that lended themselves to quantification through frequency, duration, and angle of head data. The age range appropriate to the emergence of end behavior is also presented in this figure.

The scales reviewed suggest three positions to evaluate head control: prone, pull to sit, and supported sitting. Other positions were presented in some of the tools reviewed but these behaviors were not easily quantified and therefore were not included.

Using only the behaviors in the rectangles would provide no information on the acquisition of head erect behavior. Additional measurement techniques (frequency, duration, and angle) in conjunction with clearly defined behavioral definitions allow quantification of these behaviors.

The development of quantitative assessment procedures to measure head erect behavior will provide teachers with a more sensitive tool to determine the effectiveness of their teaching strategy and to evaluate curriculum content. Comparison of treatment technologies utilized in the facilitation and acceleration of head erect behavior will also be possible with the longitudinal application of these procedures. Further research using these methods with handicapped and nonhandicapped children will provide information allowing comparisons between these two populations concerning the rate of skill acquisition, in addition to similarities and differences in development.

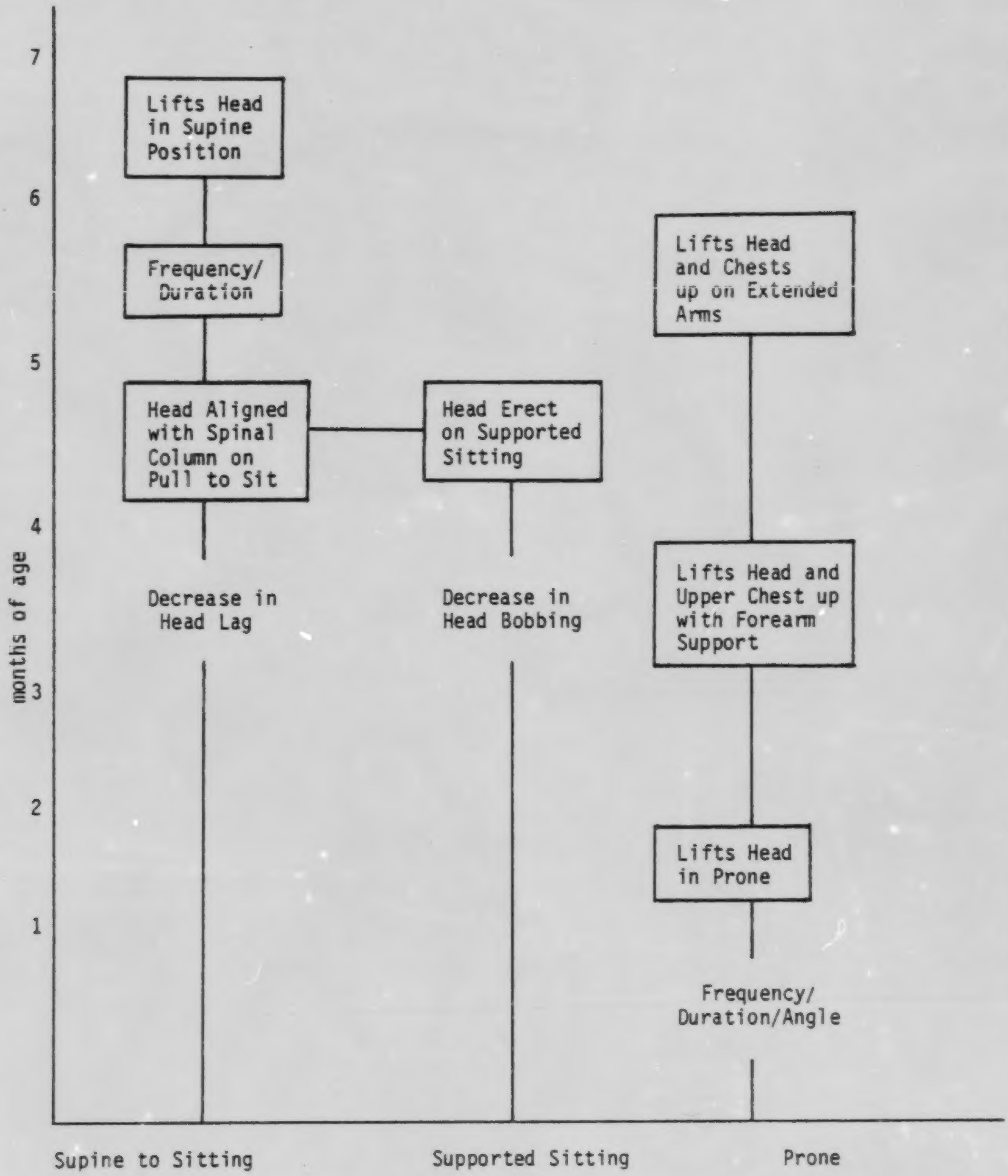
7
6
5
4
3
2
1
months of age
Lifts Head in Supine Position
Frequency/ Duration
Head Aligned with Spinal Column on Pull to Sit
Decrease in Head Lag
Head Erect on Supported Sitting
Decrease in Head Bobbing
Lifts Head and Chests up on Extended Arms
Lifts Head and Upper Chest up with Forearm Support
Lifts Head in Prone
Frequency/ Duration/Angle
Supine to Sitting
Supported Sitting
Prone

Figure 1. Quantifiable head erect behaviors.

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Procedures for Measuring Head Erect

by

Kathleen J. Foshage[1]

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[1] The procedures reported in this study were taken from a master's thesis conducted by Kathleen J. Foshage that was submitted to the Department of Special Education at the University of Kansas in October, 1978.

Measuring Head Control

Areas for measuring three critical forms of head erect behavior have been described earlier in figure 1. They include: (1) head erect in the prone position; (2) head erect in a supported sitting position; and (3) maintenance of head erect while being "pulled-to-sit" and reclined-to-supine".

Head Erect in the Prone Position

These procedures are designed to measure the frequency and duration of the child's head raises when he is placed on his stomach. The position of the child's arms when his head is raised is also measured.

Materials and Equipment

A data sheet, cumulative stopwatch, and pencil are necessary. Two types of reinforcers for head erect behavior are recommended; manipulatables and consumables.

Manipulatable. Identify the child's preferred toys. Request the child's parents (or teachers) to provide information on which type of stimulation (i.e., food, vibration, touch, etc.) will elicit and maintain a functional response from the child. If no preference information is available, present a variety of objects to the child and determine his preferred ones. The child may demonstrate preference by fixating on an object, or reaching for it, or otherwise responding positively to its presentation. Periodically probe the child's interest in other objects to determine if the initial objects remain the child's preferred ones. Potentially reinforcing objects include:

1. Visually interesting toys with bright colors and moving parts: rotating lamps, mobiles, flashing lights, t.v. etc. These items allow head

erect to be measured in a variety of positions.

2. Auditorily stimulating toys, such as music boxes, bells, and "See and Say," that can be activated when the child's head is appropriately erect.

3. A vibrator that can be applied to any part of the body except the neck (to avoid stimulating extensor muscles).

Consumable. Foods and liquids may be used to reinforce head erect behavior. Liquids can be placed in a squeeze bottle with a spout so that a few drops can be dispersed into the child's mouth when the child's head is raised. Use foods that can be given immediately and eaten easily and quickly (e.g., M & M's).

Observational Settings

Conduct measures of head control in the prone position (and the other two positions) in both structured and unstructured settings.

Structured observations. Make these observations when head control is a treatment goal. Their purpose is to assess the child's ability to display head erect behavior when an attempt is made to specifically elicit this response. No verbal cues are to be given. Without giving any verbal cues, attempt to gain the child's attention by holding a toy within his visual field, and then moving it to the midline position. This may elicit an attempt by him to raise and turn his head to the midline position to see the object. If a sound-producing toy is used, manipulate it so it sounds only when the child lifts his head.

Unstructured observations. These observations should take place during an activity that regularly occurs. Their purpose is to assess the child's ability to display head erect behavior under natural conditions without the aid of a specific prompt. These may include activities where head erect behavior (in a prone position) is a prerequisite to the activity, but not the goal of training (e.g., reach and touch program, visual tracking, etc.). These observations may be taken in the home or treatment setting. Place the child on a floor or table. Make the toys available 12-18 inches in front of him in the midline of his body. Adjust the observations to the child's fedding and sleeping schedule to avoid drowsiness or hunger, and do not attempt to specifically elicit the response.

Positioning the Child

1. Place the child prone (on stomach) on a floor, mat, or table.
2. Flex his elbows and place his hands on either side of the head.
3. Extend, abduct, and externally rotate the legs.

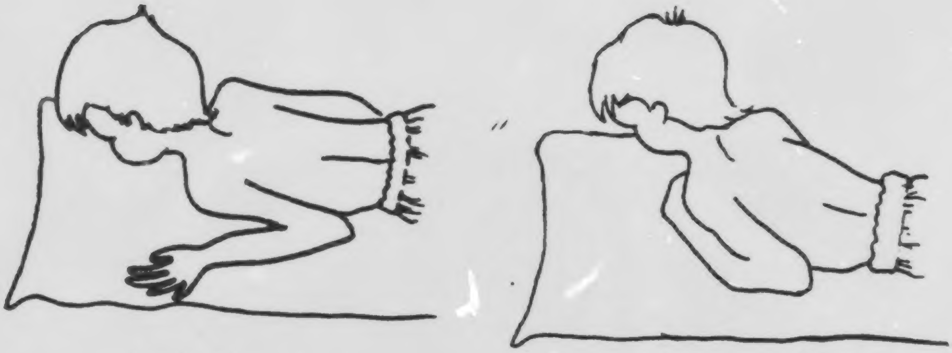
If the child places his hands or fingers in his mouth, remove and reposition them directly above his shoulders on either side of the head. If he attempts to roll over, stop and reposition him. If abnormal muscle tone develops during the observation, reposition the child but do not stop the observation. Abnormal tone is indicated by scissoring of the arms and/or legs, and/or hyperextension of the neck.

Behavior Definitions

The terms defined below describe positions of the head and arms during the measurement procedure. These positions are illustrated in Figure 2.

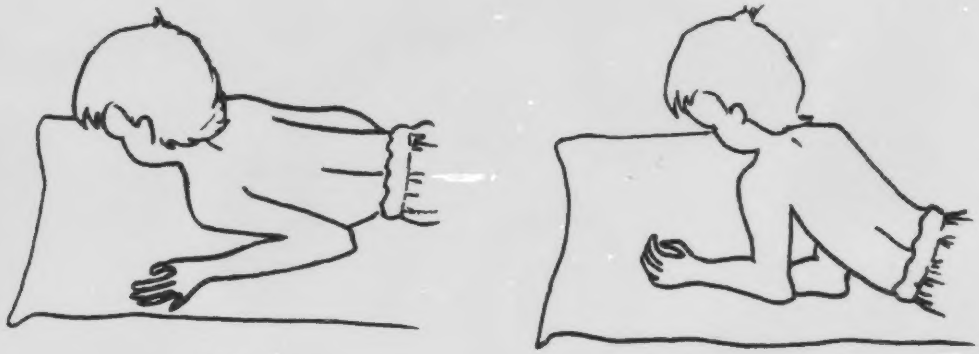
1. Head bob. The head is raised and remains up less than or equal to 5 sec before contacting a supporting surface.

2. Head erect. When no part of the head or neck (chin to clavicle) is touching the supporting surface. If the head rests on or touches the arms when they are being used as supports, head erect is not occurring.



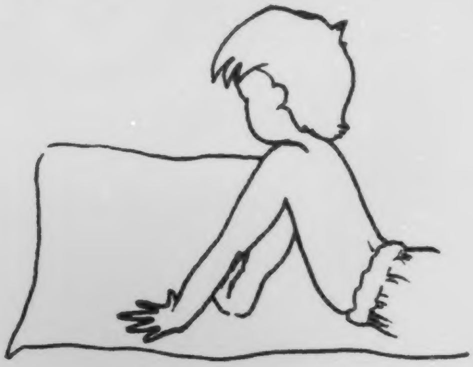
a. Head bob

c. Head up without forearm support



b. Head erect

d. Head erect with forearm props



e. Head erect with extended arm props

Figure 2. Illustrations of the head and arm positions

3. *Head up without arm support*. The head is raised and remains up longer than 5 sec before contacting a supporting surface, with an elbow angle of less than 90°.

4. *Head erect with forearm props*. The head is raised and remains up more than 5 sec with one arm elbow angle more than 90° and other arm not touching a supporting surface. This excludes any arm raising behavior involved in rolling over that can be prevented by the examiner.

5. *Head erect with extended arm props*. The head and chest are raised and remain up longer than 5 sec with no part of the arm touching a supporting surface. Only the hands are touching the surface.

Combinations of these arm positions can occur. One arm may be in one position and the other in a different position. Score these "combinations" on the data sheet also.

Measurement Procedures

Take frequency and/or duration measures of head erect behavior. To determine which measure to use (Schedule A or Schedule B described below) perform an initial observation session. Observe the child for 3 min and record the cumulative duration of all head erect behavior. Do not record arms positions during this preliminary step. If the cumulative duration of head erect is less than 60 sec, observe the child using Schedule A. If the total is greater than or equal to 60 sec, observe the child using Schedule B.

Observation Schedule A. Use this schedule with children who sustain head erect behavior for less than 60 sec of the 3 min initial observation. First place the child in the starting position and observe him for 3 min, allowing the stopwatch to run continuously. During this time record his head erect behavior using the position abbreviations shown on the data

Name:____________________ Location: ☐ Home ☐ School

Date:____________________ Setting: ☐ Structured

Age:____________________ ☐ Unstructured

Examiner:________________ ☐ Group ☐ Individual

Time:_______ Start _______ Stop

Code: B - bob

+ - no arm support

√+ - props on one forearm, other arm no support

√√ - props on forearms

√ - props on one forearm, other arm is raised

√/ - props on one forearm and one extended arm

// - props on extended arms

/ - props on one extended arm, other arm is raised

Responses or Trials	Duration	Arm Position(s)
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		

Figure 3. Data sheet for measuring head erect in the prone position.

sheet in Figure 3. This self-explanatory data sheet is required to observe on both schedules. If the child raises his head longer than 5 sec, record the duration of this head raise (in seconds) and note the position of the child's arms.

Observation Schedule B. Follow this schedule with children who sustain head erect behavior for 60 sec or longer during the initial observation.

First place the child on his stomach and present the stimulus. If the child does not raise his head in 30 sec, end the trial and record a zero on the data sheet. If the child does raise his head within 30 sec, time and record the duration of the response (including the position of the arms). Beginning when the head raises above the supporting surface. If abnormal tone is observed during the probe trials (to be described), stop the session, record the time, and reposition the child. (Mark an asterisk on the data sheet next to the appropriate trial to indicate that the trial was interrupted.) To begin each trial, reposition the child and again present the stimulus. Conduct a minimum of 5 to 10 trials. Use the same data sheet as required in Schedule A.

During head lifts, the stimulus may be moved horizontally to maintain the child's eye contact or vertically to prompt the child to raise his head higher. If the child lowers his head, but does not touch the supporting surface, hold the stimulus at this level and slowly raise it.

Change from the 3 min observation periods to the discrete trial measure (Schedule A to B) when the child maintains a head erect position for 60 sec during a 3 min period. To use this criteria sum only occurrences of head erect greater than 5 sec in length.

Data Analysis

It is suggested that two measures of head erect be tabulated. These are (1) number of head bobs per minute; and (2) duration of the longest head erect response per 3 min observation.

Head bobs/minute. In observation Schedule A, the number of head bobs are recorded during the observation period. This includes head raises of less than 5 seconds. A head bob per minute frequency can be tabulated by dividing the total number of head bobs during each 3 min session by three.

$$\frac{\text{total head bobs/session}}{3} = \text{\# of head bobs/minute}$$

Tabulate this rate by session for the child.

Duration. In observation Schedules A and B, the duration of head erect behavior is recorded. Using either schedule, the longest occurrence of head erect behavior for each session can be determined.

Graph the data for both head bobs/minute and the longest duration of head erect on the same scale. Indicate on the left horizontal axis head bobs/minute; on the right horizontal axis record longest duration of head erect behavior per observation period. Then use this graph to follow the transition between head bobs and the increased duration of head erect behavior for the child.

Head Erect in the Supported Sitting Position

The procedures are designed to measure the frequency and duration of the child's head raises while he is seated in the examiner's lap.

Materials and Equipment

Appropriate data sheets, a cumulative stopwatch, table, and chair are needed. A modified sheet of plexiglass (described below) is also required. This apparatus is also used in measuring head erect in the "pull-to-sit" and "recline-to-supine" positions.

Measurement frame. A 2' x 2' sheet of plexiglass (or use blackboard of the same dimensions) is necessary. Using ½" wide tape, divide the plexiglass into three trisections (30° angles). Number the trisections 1, 2, and 3 with 1 encompassing the length of the bottom edge, 2 in the middle, and 3 encompassing the length of the vertical edge (see Figure 4).

If you desire a portable unit, cut a groove just wide enough to allow the plexiglass (or blackboard) to fit in a board 3" x 4". A hole can be drilled through the top and a leather strip inserted to be used as a handle. The portable unit must be divided into trisections after it is fitted into the wooden groove since the support board will raise the plexiglass (or blackboard) off the surface slightly.

Foot blocks. If it is necessary to raise the examiner's knees to provide a horizontal base of support for the child, construct foot blocks from telephone books, cardboard bricks, etc.

Reinforcers. The same reinforcers used to consequate head erect behavior in the prone position can be used for head erect behavior in the supported sitting position.

Observational Settings

Structured observation (see p. HE21). In this setting have a second examiner provide visual or auditory stimulation by holding interesting objects at or above the child's eye level to encourage the child to maintain head erect behavior.

Unstructured observations (see p. HE21). Provide no additional visual or auditory stimulation. Seat the child where he can observe ongoing activity in the room.

Positioning the Child

Implement the initial positioning and movement of the child as follows:

1. Remove all clothing from the upper part of his body.

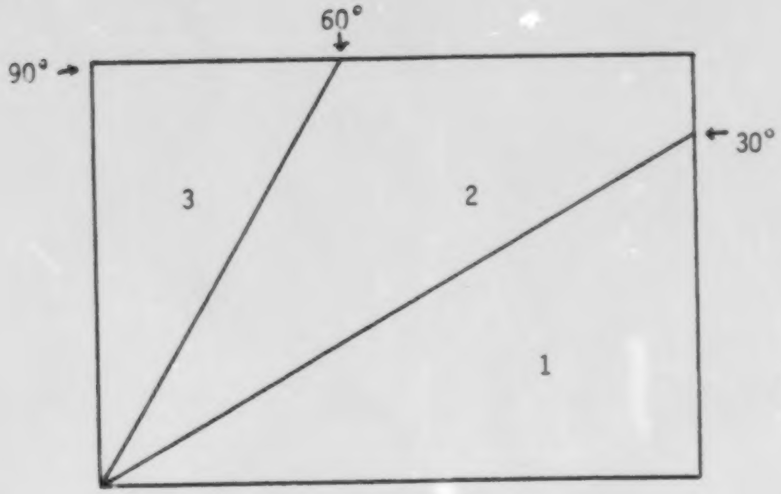


Figure 4. Trisection device.

2. Place the trisection device on the table.

3. Place the chair of appropriate height parallel to the trisection device. The height of the chair and the table must be coordinated so the child's waist is even with the bottom edge of the trisection device when the child is seated on the examiner's lap facing the same direction as the examiner. Use foot blocks, if necessary, to raise the examiner's knees so that her hips and knees form a horizontal line.

4. Position the vertical edge of the trisection device containing Trisection 3 so that it bisects the child's trunk into front and back halves as shown in Figure 5.

5. Support the child at the waist if he is able to maintain his trunk in a vertical position for 30 sections. Support him at the shoulders to maintain the vertical trunk position if he cannot voluntarily maintain this position for 30 seconds. Do not allow the child's head to touch the examiner's chest.

Behavior Definitions

Head erect behavior is scored when no part of the head (excluding hair) is lower than 60° (i.e., below the third trisection), the child's neck is not hyperextended, and the entire head has not moved beyond the vertical edge of the trisection device (90° edge).

Measurement Procedures

Frequency and duration measurements are made of head erect behavior in the supported sitting position. To determine which measure to use, position and observe the child for 3 min initially. During this period, record the duration of the behavior using a cumulative stopwatch according to the definition given above. Make sure a second person provides visual or auditory stimulation by holding objects at or above the child's eye level.

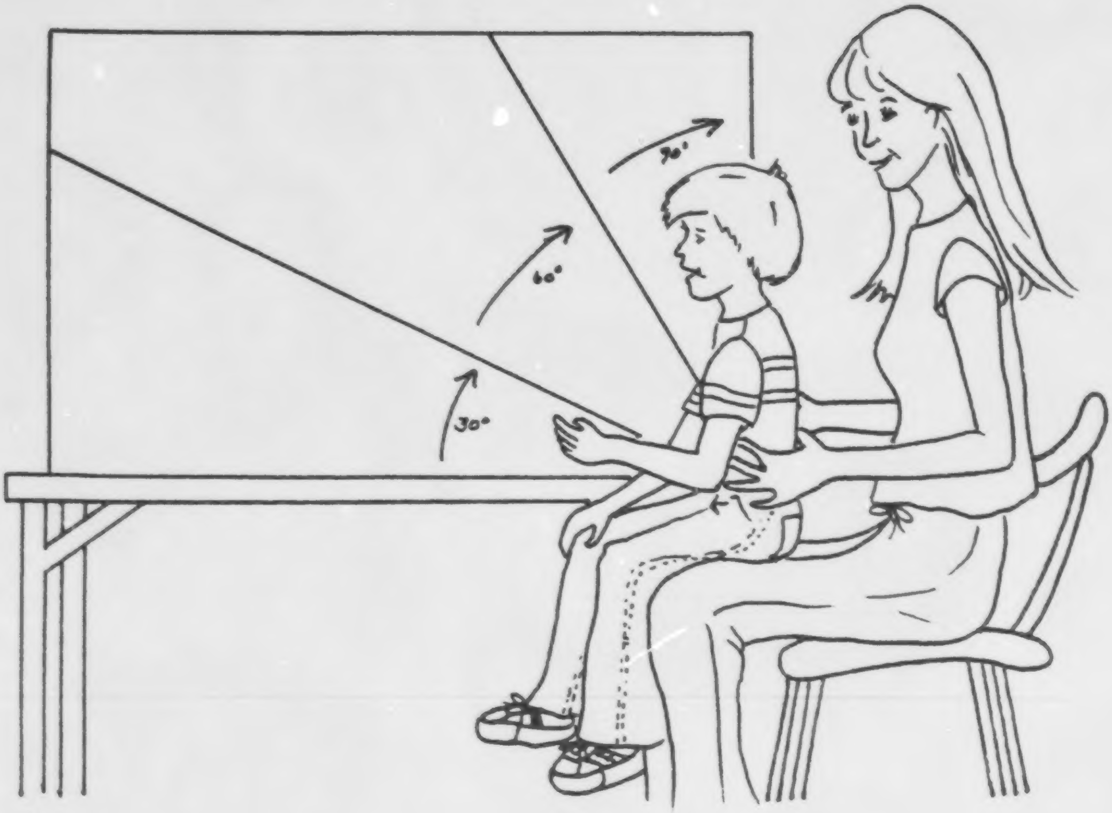


Figure 5. Correct position for measurement in supported sitting.

If the child holds his head erect for 25 or more cumulative seconds during the 3 min period, use a duration measure for all subsequent observations. If the child does not maintain head erect for 25 cumulative sec or more during the observation, use a frequency measure for subsequent observations.

Duration. To measure duration, start the stopwatch when no part of the child's head (excluding hair) is below the 60° line on the trisection device and when the head is not hyperextended. Stop the watch when any part of the head (excluding hair) falls below the 60° line, when the neck hyperextends, or when the entire head moves beyond the vertical (90°) edge of the trisection device.

Frequency. To measure frequency, record a response occurrence each time the child's head moves above the 60° line on the trisection device, when the neck is not hyperextended, and when the head is not beyond the vertical (90°) edge of the trisection device.

Record responses on a data sheet like that presented in Figure 6.

Data Analysis

Frequency. Tabulate the number of times during the 3-min period in which the child's head raises above the 60° line on the trisection device. Then calculate frequency per minute by dividing the total responses by three. Graph these data by observation session, as described in the prone position.

Duration. For each session determine the longest time that the child maintained the head erect position. Alternatively, tabulate the total time per session that the child's head was erect.

Graph the data by observation session, as described in the prone position.

Head Erect in the Supported Sitting Position

Name: ____________________	Location:	Home School
Age: ____________________	Setting:	Structured
Examiner: ________________		Unstructured
Observer: ________________	Support:	Shoulders
Observation Time: __________		Waist
Frequency-Duration		
Head Erect (circle one)		

Date: ____________________	Location:	Home School
Examiner: ________________	Setting:	Structured
Observer: ________________		Unstructured
Observation Time: __________	Support:	Shoulders
Frequency-Duration		
Head Erect (circle one)		

Date: ____________________	Location:	Home School
Examiner: ________________	Setting:	Structured
Observer: ________________		Unstructured
Observation Time: __________	Support:	Shoulders
Frequency-Duration		Waist
Head Erect (circle one)		

Date: ____________________	Location:	Home School
Examiner: ________________	Setting:	Structured
Observer: ________________		Unstructured
Observation Time: __________	Support:	Shoulders
Frequency-Duration		Waist
Head Erect (circle one)		

Figure 6. Recording head erect in the supported sitting position.

Head Erect in the Pull to Sit and Recline to Supine Position

The procedures described for these positions are intended to measure the angle of the child's head in relation to his body while he is being pulled to a sitting position and while he is being lowered back to a supine position.

Materials and Equipment

Required materials include a data sheet, the trisection device described in the previous section and the following special materials.

Velcro band. A velcro (3/4" wide) strip long enough to fit around the largest child's chest just under the arms.

Velcro loop. Cut 10 small pieces of velcro (1" x ½") from the soft (fuzzy) portion. Use these to secure the surgical tape to the opposite piece of velcro previously secured across the child's chest.

Tape. Cut strips of surgical tape (#1535 - 1" x 10 yds, 3M Micropore brand surgical tape) in strips long enough to reach from the middle of the child's chin to the velcro band around the child's chest plus one inch. Wrap one end of the tape around the velcro loop and adhere it to itself (see Figure 7).

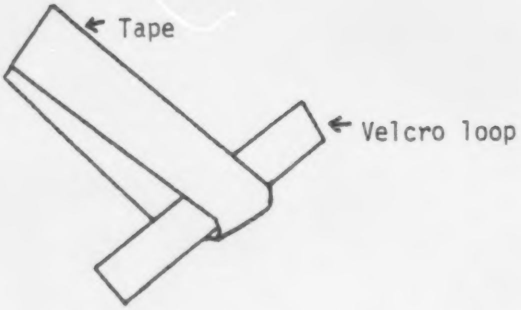

Tape
Velcro loop

Figure 7. Velcro loop and tape.

Headrest. Use sandbags on both sides of the child's head to maintain a midline position when the child is prone, or use a commerically available headrest (removed from a wheelchair) for the correct positioning.

Reinforcers. The same reinforcers used in measuring head erect in the prone position and supported sitting position are sufficient.

Observational Settings

Structured observations (see p. HE21). These measurements should be taken twice weekly during the implementation of a pull-to-sit and recline-to-supine treatment program, or at different times of day to avoid fatiguing the child. Five trials (pull-to-sit and recline-to-supine) should be performed. A toy may be placed on the examiner's head or shoulder (attached by velcro) to encourage the child to raise his head.

Unstructured observations (see p. HE21). Place the trisection device on a diaper changing table to record data as the child is reclined prior to having a diaper changed and as the child is pulled to sit after being changed. Similar situations that the child normally encounters may be substituted. A minimum number of trials is not required.

Positioning the Child

To position the child, implement the following procedures:

1. Place the trisection device on the floor or on a table.

2. Remove all clothing from the upper part of the child's body.

3. Place the velcro band around the child's chest directly under his arms as shown in Figure 8. Tighten the band after it is in place by adjusting the two points of adherence, one under each arm.

4. Fasten one end of the tape around the velcro loop and back onto itself. Center the velcro loop, with tape already attached, on the front of the band.

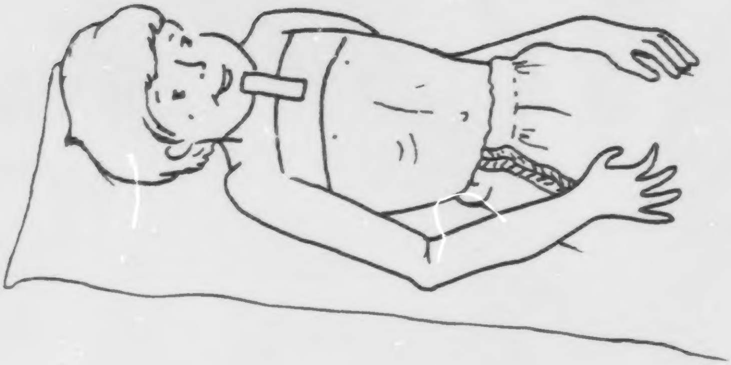


Figure 8. Correct placement of velcro loop and tape.

5. Place the child in a supine position parallel to the trisection device, so that his waist is even with the vertical end of the device. His head must be flat on the floor and maintained in midline with a headrest if necessary as shown in Figure 9.

6. Attach the free end of the tape to the middle of the child's chin so that there is no slack. Note: Attach the tape while child's mouth is in its usual position. For example, if his mouth is usually open, attach the tape while it is open. If the mouth is open during pull to sit and recline, but not at other time, hold the child's mouth open to attach the tape.

7. Flex the child's knees and place his feet flat on the floor. To maintain this position the examiner may have to externally rotate and flex his/her knee and place the child's flexed knees over his/her calf.

Behavior Definitions

Score head erect behavior for each trisection as the child is pulled from the supine to the sitting position, and lowered back from the sitting to the supine position. Score head erect behavior only if the following two conditions are met: (1) the tape remains attached, and (2) the head is not resting on the child's chest.

Measurement Procedures

As the child is being pulled to sit, or reclined, record the number of trisections in which his head remains erect. Conduct five trials of pull to sit and five of recline to supine. Implement the procedures described below.

1. Use either the child's hands or shoulders as a point of contact for the pull-to-sit and recline maneuver. Base this on the child's ability to assist with his arms in the maneuver. That is, if the child can assist

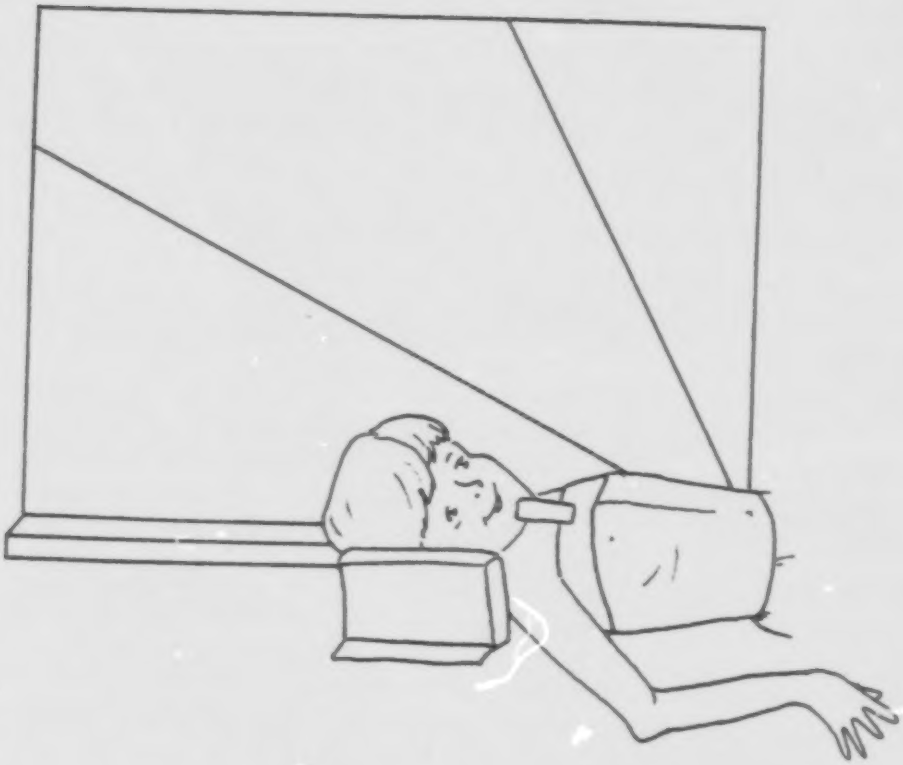


Figure 9. Correct body alignment with the trisection device.

in pulling, grasp the child's hand prior to the trial. If there is none, or only minimal contraction present, use the shoulders as the point of contact instead. In this case, fold the child's arms across his chest and then place one hand on each shoulder.

2. To conduct a trial, pull the child to the sitting position then lower him/her back to the supine position. To start the trial, first instruct the child to "sit up," then grasp him at the appropriate place (hands or shoulders), and pull him straight up into the sitting position. Then place the child's head in the midline position prior to beginning the movement back to the supine position. When moving back to the supine position, grasp the child at the appropriate place (hand or shoulders) and lower him to the floor.

3. Regulate the duration of a trial by counting 1 sec per trisection so that the ascent and descent each requires 3 seconds.

4. Have a second examiner record the trisections in which the child demonstrates head erect behavior and in which trisections he does not.

5. Use three symbols for recording the data: (1) (+) head is erect; (2) (-) head is not erect; (3) (0) tape is detached. The head is defined as erect if the tape is attached and the child's head is not resting on his chest. For each trisection that this occurs, the observer marks a plus (+) on the data sheet (see Figure 10) for the appropriate trisection. When the tape detaches, the observer records the trisection number (1, 2, or 3) corresponding to the posterior part of the child's ear. The observer marks a (0) for this trisection and marks the previous trisection appropriately (+). For example, if the tape detaches at 30°, then trisection 1 is marked (+) and trisection 2 is marked (0) on the ascent (pull-to-sit). If the tape detaches at 30° on the descent, trisection 2 is marked (+) and trisection

1 is marked (0). Any trisections moved through after the tape has detached are marked (-) along with any trisections in which the child's head is resting on or near his chest.

6. Conduct five trials each of pull-to-sit and recline-to-supine. Provide brief rests between trials as needed.

Data Analysis

Tabulate the data for the pull-to-sit and recline poisitons by recording, for each trial, the number of trisections in which head control was observed (+). Each trial requires that six scores be recorded. These include three scores (each trisection) as the child is pulled to a sitting position, and three scores (each trisection) as the child is lowered back to the supine position. Since five trials (pull-to-sit and recline) are administered in a session, a total of 30 scores are recorded. These scores can be converted to a percent correct for the session by dividing the total number of correct (+) by 30 and multiplying by 100. Data can be graphed across sessions to show the percent of head control.

Location: Home School Name: ______________

Structured Unstructured Date: ______________

Group Individual Age: ______________

Examiner: ___________

Time: _____ Start _____ Stop Time: _____ Start _____ Stop

	Pull to Sit					Recline					
	Trisection					Trisection					
Trials	1	2	3	Hands	Shoulders	Trials	3	2	1	Hands	Shoulders
1						1					
2						2					
3						3					
4						4					
5						5					

Figure 10. Date sheet for measuring head erect in the pull to sit and recline positions.

Review of Measurement Instruments and Procedures for Assessing Sitting Behaviors: Implications for Quantitative Measurement

by

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[1] Preparation of this paper was partially supported by a grant from the Bureau for the Education of the Handicapped (USOE 300-77-0308).

This is a review of the literature on the measurement of sitting behaviors. The review of sitting behavior includes. come to sit propped sitting, supported sitting, unsupported sitting and protective reactions. "Come to sit" includes behaviors of which the child assumes a sitting posture. In the child this begins with using trunk rotation to attain a sitting position from a supine position. The older child can come to sit from a prone, supine, or sidelying position. "Propped sitting" is described when the child maintains a sitting position using his arms for support. The arms may be placed in front of the child or to the sides. "Supported sitting" is defined when the child maintains a sitting position as an examiner holds the child's back to provide trunk control. Pillows or a back rest are sometimes used in lieu of an examiner's hands. "Independent sitting" is defined when the child maintains a sitting position without external support. "Protective extension reactions" are the child's reflexive movements to catch himself or maintain his balance when he begins to fall out of the sitting position. Protective extension reactions include extensions of the arms to either side of the trunk, to the back of the body, or to the front of the trunk.

The importance of sitting is seen in situations where the child is expected to attend to, and interact with, the environment. Sitting allows the child to have a greater visual field and thereby more access to information from the immediate environment. When the child can sit independently he is free to use his hands to manipulate objects. The postural control that is gained in independent sitting is a prerequisite for standing and walking.

Developmental scales and checklists were reviewed in order to determine how sitting was assessed, and information was sought from research about the development of sitting behavior. The review included: 1) assessment instruments relevant to sitting; 2) research related to sitting behaviors; 3) the identification of developmental milestones in this area; and 4) a proposed lattice for the development of sitting skills resulting from a distillation of the literature reviewed.

Standardized Developmental Scales and Checklists

Developmental scales and checklists were included in this section of the review if they met the following four criteria: 1) the items related to sitting behavior that emerged prior to 12 months; 2) the behaviors were ordered in accordance with a hypothetical developmental sequence of emergence; 3) the behaviors in question were observable; and 4) the instruments had been standardized.

The five scales reviewed, included the Bayley Scales of Infant Development (Bayley, 1969), Developmental Schedules (Gesell, 1928, Gesell and Thompson, 1934; Gesell and Amatruda, 1941), Denver Developmental Screening Test (Frankenburg, Dodds, and Fandal, 1974), and the Griffiths Mental Development Scale (Griffiths, 1954).

Details of appropriate settings for use of the instrument varied widely. The Bayley Scales of Infant Development provided specifications for equipment used such as, "The crib sides should be low enough to provide the examiner easy access." (p. 24). Further "The examining room should be large enough to include an examining table, chairs for adults, a youth chair for the child, a crib and a playpen. The room should be pleasant." (p. 24). The setting for the Developmental Schedules requires only a slight adaptation from a conventional physician's office examining room. For instance, "a free flat surface is needed where the child can demonstrate postural control, and a bed tray table for placing materials", (Gesell and Amatruda 1941, p. 17). Drawings are used to illustrate some positions such as supported sitting. This drawing shows a child seated on an examining table with the examiner standing behind the child giving trunk support. In this case, materials are placed in front of the child on a low-tray-type table. The Griffiths Mental Development Scale specifies that the room should not be too large as to appear forbidding and there should be large toys to provide atmosphere. The Denver Developmental Screening test did not specify any special environment or equipment.

All the assessments and checklists reviewed stated that the child should be put at ease during the testing situation. The Denver Developmental Screening Test stated that all testing should be done prior to undertaking any potentially painful procedure with the child.

The Developmental Schedules prescribed different sequences for assessing the child's behavior according to his chronological age. For example, at four or sixteen weeks the examination begins with the child in a supine position, however at 28 weeks it is assumed that the child has gained enough trunk control to be examined in a sitting position. The Developmental Schedules included specific procedures for positioning the child during the assessment. For example, in describing supported sitting, the examiner is told to put his hands around the child's thorax with the examiner's thumbs along the child's back.

The number of sitting positions that were to be measured varied widely. The Developmental Schedules had the greatest number of component behaviors. For example under unsupported sitting, the Developmental

Schedules scored sitting unsupported for one minute, sitting unsupported indefinitely, sit and pivot, and sit and regain sitting. The Bayley Scales of Infant Development did not consider head lag in pull to sit, but it scored the child on pulling himself into a sitting position. The Griffiths Mental Development Scale was unique in scoring whether the back was firm when held in a sitting position. The Denver Developmental Screening test covered the least number of items in relation to sitting. These were simply pulls to sit with no head lag, and sits without support.

The Bayley Scales of Infant Development provided materials such as the wooden cubes used for testing fine motor development, as part of a kit that was to be purchased along with the scale. The cubes were placed on a table in front of the child and child's sitting was evaluated at the same time as his fine motor development. The Developmental Schedules and the Griffiths Mental Development Scale listed the materials needed for testing fine motor skills. None of the scales required any specific materials for sitting, however the Developmental Schedules allowed that "lures" could be used to elicit a behavior such as, regains sitting. No instrument detailed procedures for use of orthotic or prosthetic equipment.

All the instruments simply scored occurrence or nonoccurrence of the skill. Some scales used duration in their definition of the behavior to be scored. The Developmental Schedules scores sitting alone for one minute, the Bayley Scales of Infant Development scores sitting alone for 30 seconds or more.

The instruments varied with regard to their acceptance of outside information. The Developmental Schedules only accepted responses observed by the examiner during the assessment. The Denver Developmental Screening

Test, the Bayley Scales on Infant Development, and the Griffiths Mental Developmental Scale all accepted parental reports in addition to the examination results.

Nonstandardized Instruments or Checklists

There are many nonstandardized instruments available for assessing motor development. Those reviewed were chosen because they had: 1) items related to sitting that were expected to emerge prior to 12 months; 2) behaviors that were ordered in occurrence with a hypothetical behavior sequence of emergence; and 3) behaviors in question which were observable. The instruments reviewed included the Callier-Azusa Scale (Stillman; 1975), Developmental Pinpoints (Cohen, Gross and Haring, 1976), Learning Accomplishment Profile (L.A.P.) (Stanford, 1974), Manual for the Assessment of a "Deaf-Blind" Multiply Handicapped Child (Collins and Rudolph, Note 1), Marshalltown Project, Manual 1 (Donahue, Montgomery, Keiser, Roecker, Smith and Walden, Note 2), Memphis Comprehensive Developmental Scale (Quick, Little and Campbell, 1973), The Pennsylvania Training Model (Somerton and Turner, Note 3) and the Portage Project Checklist (Shearer, Billingsley, Frohman, Hilliard, Johnsons and Shearer, Note 4).

Generally there were fewer guidelines for administering the nonstandardized instruments than the standardized instruments. The Callier-Azusa, the L.A.P., and the Memphis Comprehensive Developmental Scale all specified a classroom setting for administration of the assessments. While the Developmental Pinpoints, the Memphis Comprehensive Developmental Scale and the Portage Project Checklist all specified that administration should be done after observation of the child, they did not specifiy how long the child should be observed. The Callier-Azusa Scale specified a 2-week observation period prior to administration. No assessment instruments or checklists addressed the question of when to assess or how to deal with the child's moods or behaviors.

The L.A.P. had the most detailed instructions for administration of individual items. For example, in the item, sits without support, the instruction are: "Hold the child in a sitting position on table, making sure child does not fall, slowly remove your hands." The Callier-Azusa Scale instruction were generally given as examples of what the child would do to get a passing score for protective extension. The example given was "child can freely play with toy while sitting." There is not much detail of what the examiner should do or what materials are needed. The behavioral definitions of the behavior were expected to be sufficient guidelines for administration of the Manual for the Assessment of a "Deaf-Blind" Multiply Handicapped Child, the Portage Project Checklist, the Memphis Comprehensive Developmental Scale, and the Pennsylvania Training Model. No additional instructions were provided for any of these instruments. No assessment or checklist gave instructions on the use of orthotic or prosthetic equipment.

Generally there were no specific instructions for positioning the child. The L.A.P. detailed some general directions for positioning the child. For example, for pull to sit the instructions are, "Place the child on his back." For other scales the position could be infered from the behavioral description. However, different interpretations might cause problems in scoring since one examiner might score sits unsupported as passing only if the child sits with his hands free, while another examiner might pass the child on that item when he props himself with his hands.

As with the standardized scales, all scoring was simply occurrence or nonoccurrence. The L.A.P. and the Memphis Comprehensive Developmental Scale accepted parental report. The L.A.P., the Callier-Azusa and the

Memphis Comprehensive Developmental Scale used duration was part of some of their behavioral definitions. For example the Callier-Azusa Scale stated "sits alone for 5 seconds or more." However, the Memphis Comprehensive Developmental Scale used open ended time measures such as "sits unsupported for a few seconds". Accordingly, the number of seconds for scoring is open to examiner interpretation. The Callier-Azusa Scale, the L.A.P., and the Memphis Comprehensive Developmental Scale required that the behaviors be established in the child's repertoire, but no definitions are provided for "established".

The number of sitting behaviors that were to be scored varied. The items used were comparable to those seen in the standardized scales. However, only the Pennsylvania Training Model evaluated side-sitting although this position was not specifically defined.

Research in the Development of Sitting Behaviors

Most of the literature involving sitting has been related to the establishment of developmental norms. It is the categories of sitting, as defined by the early researchers and the norms that they established, that provided foundation of our knowledge of the development of sitting. Arnold Gesell's early work is the most often referenced (Gesell, 1928, Gesell and Thompson, 1934, Gesell and Amatruda, 1941). This research was based on the longitudinal analysis of 107 children. Data were taken on when the children exhibited specific behaviors such as sitting with support, or protective reactions in sitting. The data were recorded on film and in written records and then summarized as developmental norms for the emergence of sitting behaviors. These norms were published in the Developmental Schedules. In the Developmental Schedules sitting with support is normed at 28 weeks and sitting with good postural control is normed at 40 weeks of age.

Shirley's (Shirley, 1941) norms were developed from a study of 25 children who were tested in their homes. Some of the behaviors were recorded from maternal report However, no information was included in the normals, unless the examiner concurred with the mother as a result of biweekly examinations administered to the child. Shirley found that once a child could sit alone for one minute, he could sit indefinitely. In Shirley's sample the median age for sitting was 31 weeks of age.

Illingworth (1966, 1975) reported norms for children seen in a hospital setting. He found that children sat for a few seconds with support at 32 weeks, and by 36 weeks they could sit unsupported for 10 minutes. Children could not pull themselves into a sitting position until they were 40 weeks old.

Zdanska-Brincken and Wolanske (1969) reported norms from a longitudinal analysis of 212 children. The found that children generally could sit unsupported at about seven and one-half months.

McGraw's (1934) research used stop action films to determine the sequence of sitting behaviors. The anlysis of sitting was divided into two categories. These were: a rising aspect (i.e., actions done by the child to attain a sitting posture); and a resistive aspect (i.e., postual adjustments in the body after it is vertical to the supporting surface). By analyzing the films, McGraw developed progressions of distinct motor behaviors for each of the categories. Descriptions of each phase were provided by McGraw and are summarized in Table 1. The phases were organized on data sheets that allowed observers to score occurrence or nonoccurrence of the behavior. McGraw found that generally only one phase would be scored. However, because these phases were progressive, there were transition periods during which a phase was developing but was not yet established sufficiently in the child's repetoire to obliviate the former phase. During these transition periods, observers scored several phases simultaneously.

Zachu-Christiansen and Ross (1975) reported a study of 9006 mothers and infants. They compared two categories of full birthweight normal infants (weight between 3100-3500g and weights of at most 2500g) and two categories of deviant infants (weights over 2500g and weights of at most 2500g). Deviant was defined as, infants who at one year were found to have definite signs of CNS damage or who could not stand with support. They found that at eight months there were definite differences in the groups ability to sit without support. At eight months only 43% of the deviant infants weighing over 2500g at birth and only 20.2% of the deviant infants weighing less than 2500g could sit without support compared to 80.6% of the infants weighing between 3100-3500g and 58.4% of the infants weighing, at most, 2500g.

Developmental Sequence of Sitting

The literature related to sitting was reviewed in order to identify behaviors that emerge in the develpment of independent sitting. Sitting was chosen because it is a motor behavior that allows the child to have a wide view of his environment and frees his hands to interact with objects. In addition to trunk stability and protective reactions developed in attaining independent sitting are prerequisites for standing and walking. The research reports, assessment scales and checklists were reviewed for descriptions of sitting behaviors. Behaviors with similar topographies were grouped together in order to develop a sequence of well defined sitting behaviors and a reliable system of measurement. The grouping of behaviors resulted in three major categories of sitting behaviors that were: come to sit; sitting with or without support; and protective reactions in sitting.

Within each of these categories it was possible to identify the terminal behavior (e.g., supported sitting), the behaviors preceding the terminal behavior, and the ages ascribed to the behaviors. Each category was subdivided according to component behaviors. The behaviors were ordered in the sequence of emergence as reported in the literature. Often there was some variation in the age a specific behavior was reported to emerge. Therefore, for ease of classification, the modal age referenced was used to determine the placement of a skill in a developmental progression. Protective reactions in sitting to the front, was excluded from the protective reactions category because if a child can prop sit he/she will have protective extension reactions forward and therefore it is indirectly measured in that category. With the exception of protective reactions to the front, the developmental progression determined by the review was used to construct a lattive of observable sitting behaviors. The lattice is arranged vertically in relation to the age of emergence of the behavior (see Figure 1). The lattice is arranged horizontally in the order the behavior is expected to emerge in the normal child.

Supported sitting is the first sitting behavior seen in the developmental progression. It emerges at approximately five and one-half months. Propped sitting and protective reactions to the front emerges next at approximately six months of age. The seven month old child demonstrates protective reactions to the sides. The third category of come to sit emerges at nine months with come to sit from supine using trunk rotation.

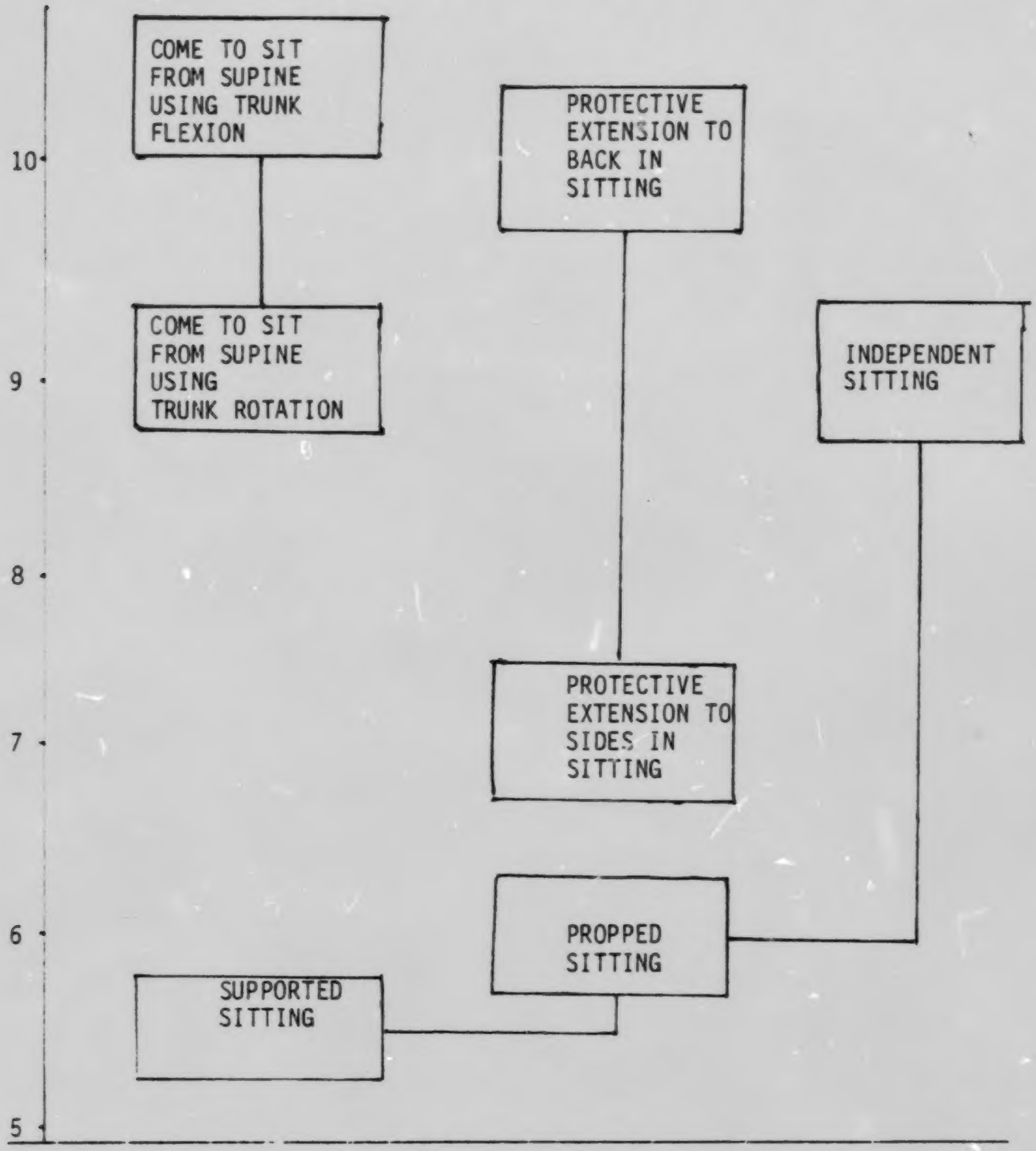
COME TO SIT FROM SUPINE USING TRUNK FLEXION
PROTECTIVE EXTENSION TO BACK IN SITTING
COME TO SIT FROM SUPINE USING TRUNK ROTATION
INDEPENDENT SITTING
PROTECTIVE EXTENSION TO SIDES IN SITTING
PROPPED SITTING
SUPPORTED SITTING
10
9
8
7
6
5

Figure 1. Lattice of Critical Skills of Sitting

From Barnes, K.J. Quantitative Assessment of Sitting Skills for Severely Multiply Handicapped Children. Unpublished theses, University of Kansas Department of Special Education, 1979.

The emergence of come to sit coincides with the emergence of independent sitting. Protective reactions to the back complete the protective reactions in the sitting category when it emerges at approximately ten months. Finally the emergence of coming to sit using trunk flexion completes, at ten and one-half months, the come to sit category and the separate identified sitting behaviors. The completion of the sitting sequence leaves the child with mastery of his trunk so that he can continue working on the leg control he needs for standing and walking. The protective reactions he uses in maintaining sitting serve him in the development of protective reactions in standing. The trunk rotation that is used in come to sit is necessary for come to stand and for walking. In the sitting position the child's hands are free to interact with objects and the child can continue to refine his reach and grasp behaviors. The child who has completed the sitting sequence is a child who is in a far better position to develop motorically and intellectually.

Table 1
McGraw's Sitting Progression

A Newborn - no resistance to gravity, when pulled to sit complete head lag, in sitting head falls forward.	A Newborn - no resistance to gravity, face rests on surface near feet.
B Orthotonic - during pull to sit head head predominantly in axis plane, no effort to bring self to sitting.	B Incipient Resistance - fleeting resistance to falling toward may jerk back and forth several times.
C Voluntary Flexion - in pull to sit flexes head forward, some flexion of trunk, legs drawn into abdomen, helps pull self into sitting.	C Exaggerated Resistance - tends to push backward into dorsal position.
D Ventral - push - rolls to prone into palm-knee or tri-pedal position, raises trunk upward and abducts one leg to sit.	D Trunkal Resistance - falls forward from vertical, remains hyperflexed, arms not engaged in supporting body, topples sideways.
E Dorsal - push - turns slightly to side, pushes up with one arm, raises legs slightly to sit.	E Sustained Resistance - supports self in sitting with arms.
	F Independent Sitting - maintains erect sitting position usually with one leg flexed and abducted.

Adapted from McGraw, M. The neuromuscular maturation of the human infant. New York: Columbia University Press. 1943, 63-70.

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Procedures for Measuring Sitting Behavior

by

Karin J. Barnes[1]

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[1] The procedures reported in this study were taken from a master's thesis conducted by Karin J. Barnes that was submitted to the Department of Special Education at the University of Kansas in 1979.

Measuring Sitting Behavior

Procedures for measuring eight different forms of sitting behavior are described below. The forms of sitting behavior include: (1) supported sitting; (2) propped sitting; (3) come to sit from supine using trunk rotation; (4) come to sit from sidelying; (5) come to sit from supine using trunk flexion; (6) protective extension to the side in sitting; (7) protective extension to the back in sitting; (8) independent sitting.

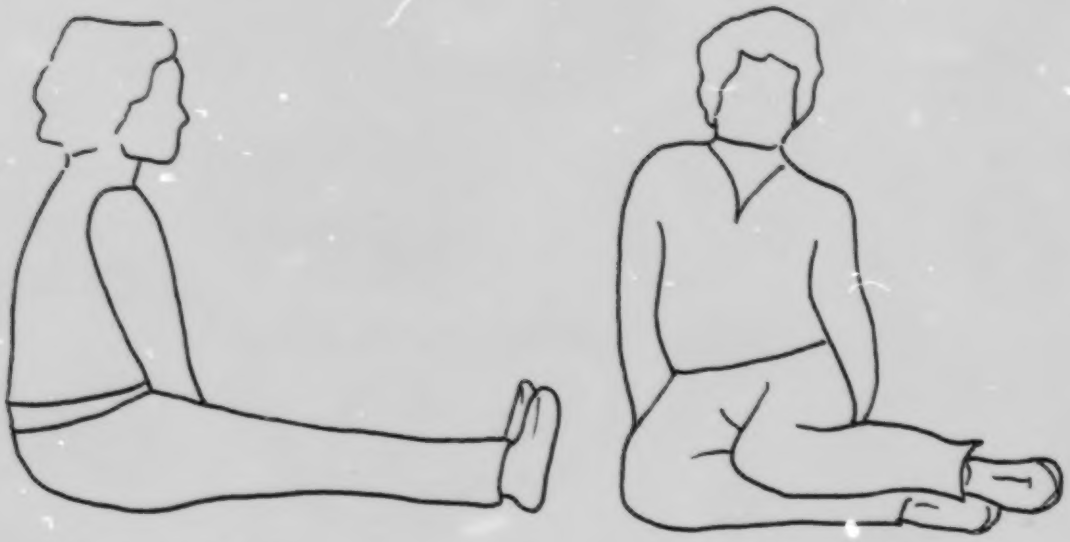
Initial Probe

Before assessing a child, probe to determine the child's optimum sitting position. Different types of physical abilities, such as spinal and hip contractures, dislocated hips, or abnormal movement patterns, may make the optimum sitting posture different from child to child. To determine the child's optimal posture, probe four different sitting positions before the actual assessment begins. Place the child in the most comfortable of the positions throughout the assessment. These probes are not part of the assessment but rather a means to facilitate optimum performance by the child.

Place the child in his optimum sitting position for each assessment task that starts from a sitting position. The four sitting positions to be probed are defined below.

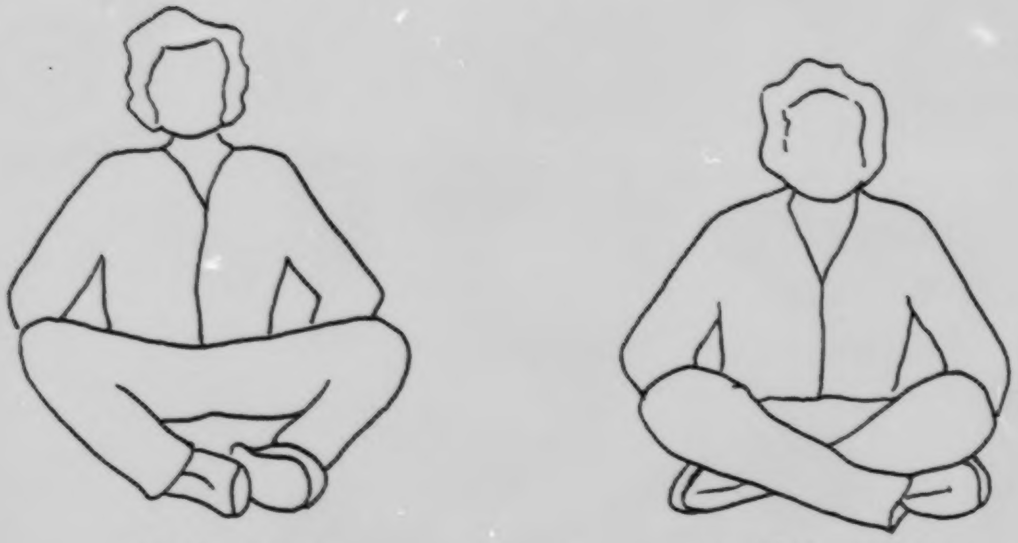
1. Long sitting. Place the child in a sitting position with his legs straight out in front of his body. This position may be the best for children that have no leg contractures (Figures 2a).

2. Side sitting. Place the child in a sitting position with his knees together. The knees should be bent and pointed to one side and the feet should be together on the other side. This position may be



a. Long sitting

b. Side sitting



c. Circle sitting

d. Tailor sitting

Figure 2. General Sitting Instruction Positions

best for a spastic child with limited range of motion in his legs (Figure 2b).

3. Circle sitting. Place the child in a sitting position with his legs spread outward and knees bent so that the feet are touching. This position may be best for an athetoid child (Figure 2c).

4. Tailor sitting. Place the child in a sitting position with his feet crossed in front of his body. This position may be used with children who have no leg contractures but need a wide base of support (Figure 2d).

1. Supported Sitting

Materials and Equipment

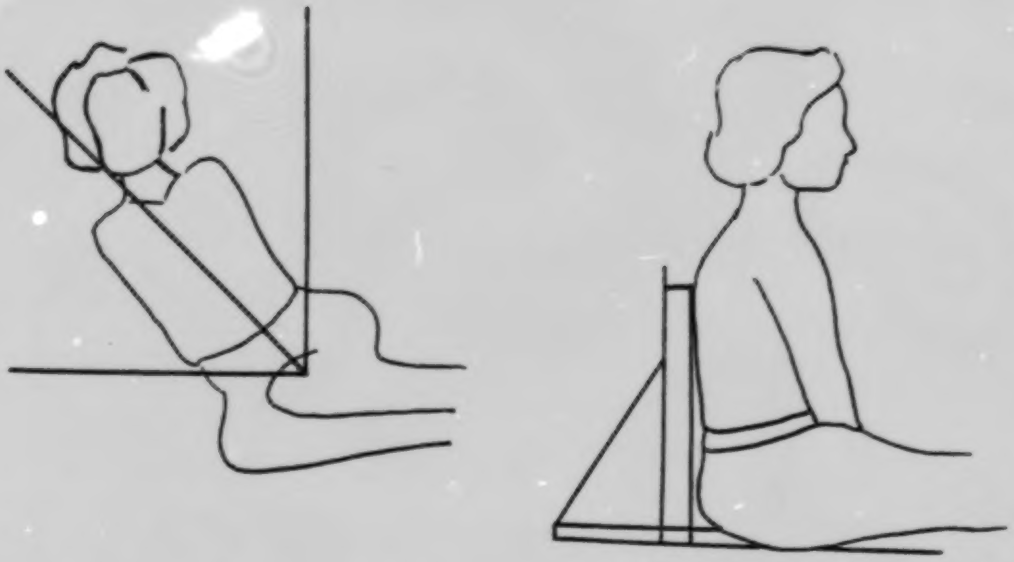
Measuring glass. Mount a 24" x 24" clear plexiglass sheet on a wooden frame. Use three strips of tape to divide the glass into trisections with angles of 30, 60, and 90 degrees (Figure 3c).

Back board. A board is needed to support the child's back. It must be no higher than the top of the child's shoulders (Figure 3b).

In addition two stopwatches, a data sheet, and a padded sitting surface (mat) are needed.

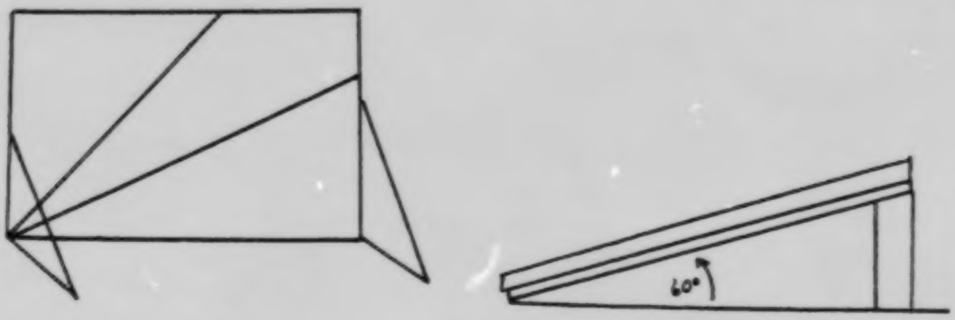
Positioning the Child.

Place the back board perpendicular to the mat and the plexiglass diagonal to it with the bottom edge resting on the floor so that the 90° angle is flush with the edge of the back board and flush and parallel to the mat. Then place the child in his optimal sitting position with his back supported against the board (hips as close to the board as possible). The child is now ready for measurement of supported sitting. The behavior definitions required in this assessment are given below.



a. Falling from sitting

b. Back support board



c. Measuring glass

d. Incline mat

Figure 3. Apparatuses used in measuring sitting behavior and illustration of falling from sitting position.

Behavior Definitions

Supported sitting. Three variations of supported sitting can be scored. All require at least the child's lower back to be against the board (Figure 3b).

Trisection 1. If the child sits so that the top of his shoulders, as viewed through the plexiglass, is between the 90° and 60° angle lines, the child is scored as being Trisection 1 (Figure 4a).

Trisection 2. If the child sits so that the top of his shoulder, as viewed through the plexiglass, is between the 60° and 30° angle lines, the child is scored as being in Trisection 2 (Figure 4b).

Trisection 3. If the child sits so that the top of his shoulder, viewed through the plexiglass, is between the 30° and 0° angle lines, the child is scored as being in Trisection 3 (Figure 4c).

Incorrect sitting. When any of the following responses occur, score the child's response incorrect and terminate the trial.

A. The child rests his head on his lap, on the back board or measuring glass, or supports it in any manner.

B. The child's back is not touching the back board.

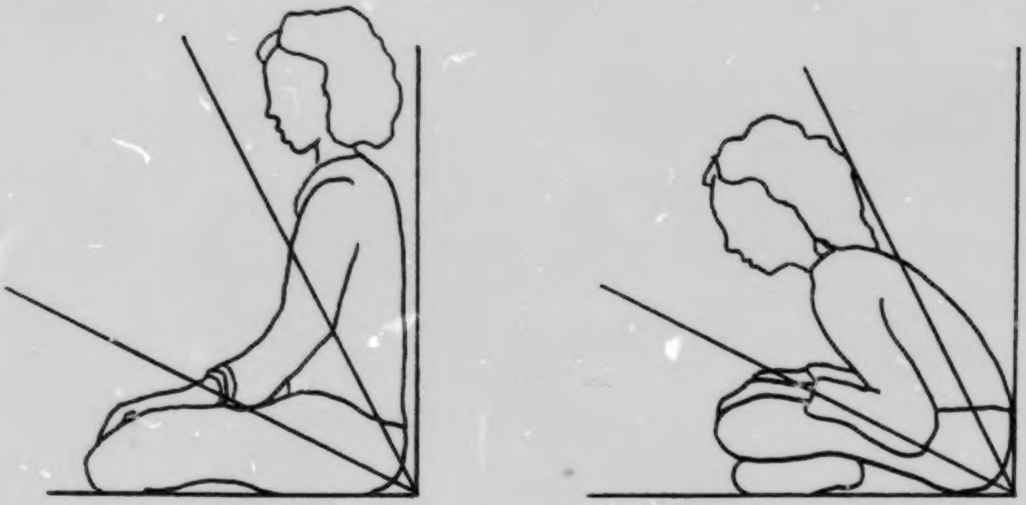
C. The child's body is tilted sideward so that his shoulder rests on the measuring glass.

D. The child grasps, with his hand, the measuring glass or back board for support.

E. The child falls or leans more than 45° laterally. (Figure 3a).

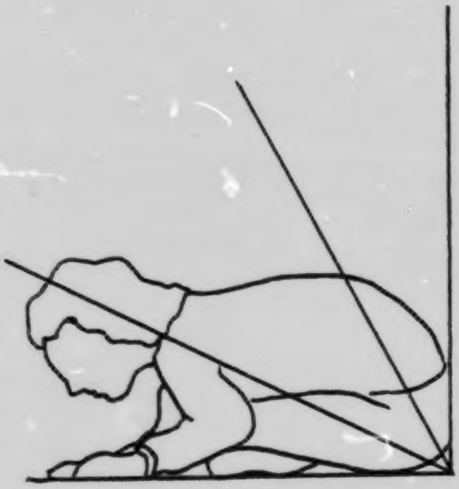
Measurement Procedures

As soon as the child is correctly positioned, remove all supporting hands from the child. The child's sitting behavior can then be observed through the plexiglass. The trial starts when the examiner removes her



a. Sitting in Trisection 1

b. Sitting in Trisection 2



c. Sitting in Trisection 3

Figure 4. Measuring in Trisections for Supported, Propped and Independent Sitting.

hands from the child. Start the stopwatch at this point. The examiner (and an additional observer) observes through the plexiglass and records the child's sitting position every 30 sec for a 5-min period, or until the child falls laterally out of position. Record the total duration the child was sitting during the trial and the amount of time spent in each position, on the data sheet. If the total duration is less than 30 sec record the position of the child before the fall and the duration of the response. When the trial ends, allow the child 5 to 10 sec to rest, then start the next trial and continue until 5 trials have been conducted. For each trial, record two types of data: the total duration of the trial itself and the total time the child spent sitting in each posture as measured by the trisection plexiglass device. See the data sheet in Figure 5 for Supported Sitting.

2. Propped Sitting

Materials and Equipment

Same as for Supported Sitting

Positioning the Child

Place the back board perpendicular to the mat and the plexiglass diagonal to it with the bottom edge resting on the floor so that the 90° angle line is flush with the edge of the back board and flush and parallel to the mat. Then place the child in his optimal sitting position with his back supported against the board (hips as close to the board as possible). Position the child so that he is able to rest his arm(s) or hand(s) on the sitting surface or on his legs or feet. The child is now ready for measurement of propped sitting. The behavior definitions required in this assessment are given below.

Subject ____________________ Examiner ________________

Date ______________________ Observer ________________

Phase _____________________ Reliability _____________

	1	2	3	4	5
1. Sitting in first Trisection					
2. Sitting in second Trisection					
3. Sitting in third Trisection					
4. Total Duration					

Figure 5. Data sheet to record responses in the supported sitting position.

Behavior Definitions

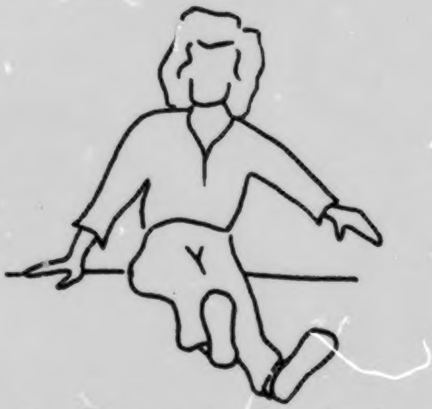
Prop on one free hand. The child is propped (weight-bearing) on one hand. The hand may be in front, to the side, or to the back as long as the hand and arm are not touching or resting on any other body part. The other hand must not be used to support sitting at all (Figure 6a).

Prop on two free hands. The child has one hand or arm propped on another body part (such as the knee or thigh). This can include: a hand resting on the mat while the elbow rests on the knee; a hand grasping a leg for support; an arm resting on the leg; or any other manner of "fixing" the arm or hand on another body part for support during sitting. Only one hand can be used to assist in support (Figure 6b).

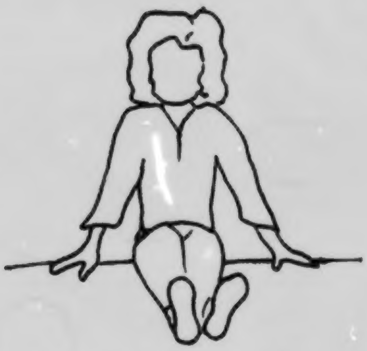
Fixed on one hand. The child has one hand and/or arm propped (weight-bearing) on other body parts. This can include: the hand resting on the mat while the elbow rests on the knee; the hand grasping a let for support; the arm resting on the leg; or any other manner of fixing the arm or hand on another body part for support during sitting. The other hand does not assist in the support at all (Figure 6c).

Fixed on two hands. The child has both hands and/or arms propped (weight-bearing) on other body parts. This can include: the hands resting on the mat while the elbows rested on the knees or legs; the hands grasping a leg for support; the arms resting on the legs; or any other manner of fixing the arms or hands on another body part for support during sitting (Figure 6d).

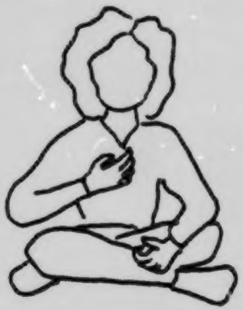
Mixed propping on two hands. The child has both arms or hands in such a manner that one hand is propped on another body part and the other is propped on the floor (Figure 6e).



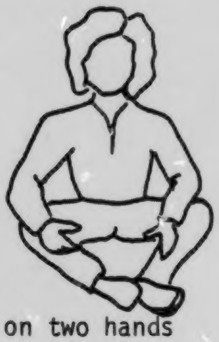
a. Prop on one free hand



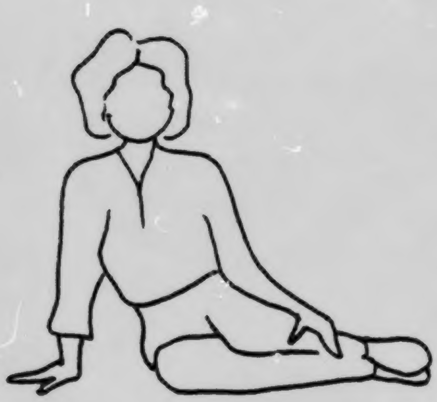
b. Prop on two free hands



c. Fixed on one hand



d. Fixed on two hands



e. Mixed prop on two hands

Figure 6. Propped Sitting: Illustration of responses

Propped sitting in Trisection 1. While the child is propped in some manner, he sits so that the top of his shoulder, as viewed through the plexiglass, is between the 90° and 60° angle lines (Figure 4a).

Propped sitting in Trisection 2. While the child is propped in some manner, he sits so that the top of his shoulder, as viewed through the plexiglass, is between the 60° and 30° angle lines (Figure 4b).

Propped sitting in Trisection 3. While the child is propped in some manner, he sits so that the top of his shoulder, as viewed through the plexiglass, is between the 30° and 0° angle line (Figure 4c).

Incorrect propped sitting. When any of the following occur, the child's response is incorrect and the trial should be terminated:

1. The child rests his head on his lap, or on the measuring glass or any other object.
2. The child rests his shoulder on the measuring glass.
3. The child grasps the measuring glass or any other object besides his own clothing.
4. When the child falls or leans more than 45° to the side. (Figure 3a).
5. The child sits independently without the use of his arms or hands to bear weight.

Measurement Procedures

As soon as the child is correctly positioned, remove all supporting hands from the child. The child's propped sitting behavior can then be observed through the plexiglass. The trial starts when all supporting hands are removed from the child. Start the stopwatch at this point. The examiner (and an additional observer) observe through the plexiglass and record the child's trisection position and type of propping on the data sheet every 30 sec for a 5-min period or until the child falls out of the position. Record the total duration the child spent in propped sitting during the trial and the amount of time spent in each position. That is, every 30 sec record the trisection the child is in and the method he is using to prop himself. If the total duration is less than 30 sec, record the position of the child before the fall and the duration of the response. When the trial ends, allow the child 5 to 10 sec to rest, then start the next trial and continue until 5 trials have been conducted. For each trial, record two types of data: the total duration of the trial itself, and the total time the child spent sitting in each posture (as measured by the trisection device) using each propping method. Refer to Figure 7a for a data recording sheet used in the propped sitting position.

Come to Sit from Supine Using Trunk Rotation

Materials and Equipment

Two stopwatches, a data sheet, and floor mat.

Positioning the Child

This procedure is used to assess the child's ability to come to a sitting position from the right and/or left side. Place the child in a supine (back lying) position on the mat.

Behavior Definitions

Rotate head. When the child rotates (rolls) his head to one side. (That side rotated to is then called the *down* side.) The child's head must rotate enough so that his ear is in line with his shoulder (Figure 8a).

Rotate the trunk. When the child rotates his trunk to the *down* side so that the *up* side (the opposite side) shoulder is in line with

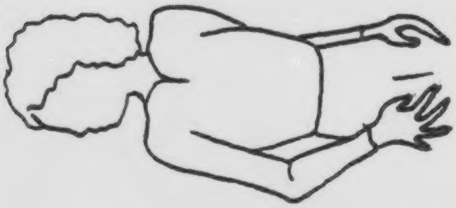
Subject ______________________ Examiner ________________

Date ________________________ Observer ________________

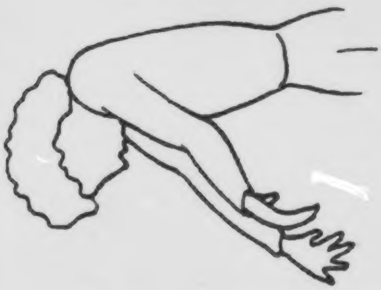
Phase _______________________ Reliability _____________

	Tally	Time	Sample
Sitting in Trisection 1			
Sitting in Trisection 2			
Sitting in Trisection 3			
Prop on 1 free hand			
Prop on two free hands			
Fixed on 1 hand			
Fixed on two hands			
Mixed prop on two hands			
Total duration of sitting			

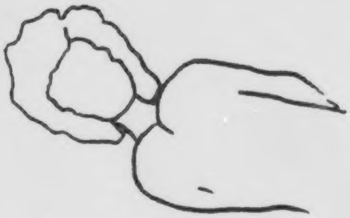
Figure 7. Data sheet to record responses in the propped sitting position.



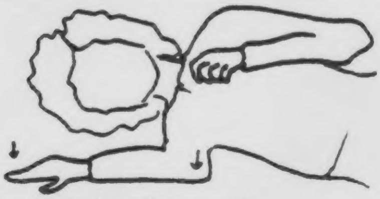
a. Rotate head



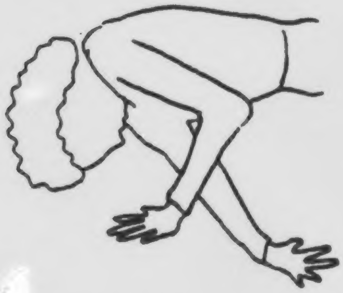
b. Rotate trunk



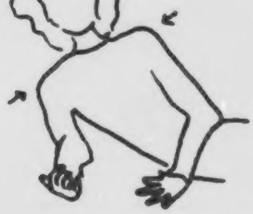
c. Head off mat
d. Down elbow on mat



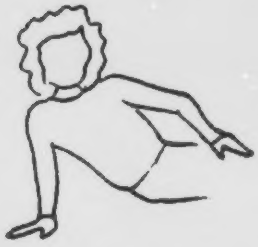
e. Down hand on mat
f. Abduct down shoulder



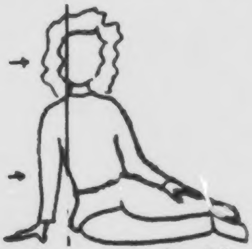
g. Up hand on mat



h. Both shoulders off mat



i. Down elbow leaves mat



j. Down ear in line with hip
k. Down elbow completely straight

Figure 8. Come to Sit from Supine using Trunk Rotation: Illustrations of responses.

the middle of the child's waist (Figure 8b).

Head off the mat. When the child's head is raised off the mat enough so that the examiner is able to slide a hand under the head (Figure 8c).

Down elbow on mat. When the child's down elbow contacts the mat (Figure 8d).

Down hand on mat. When the child's down hand contacts the mat (Figure 8e).

Abduct down shoulder. When the child's down elbow moves out away from his trunk so that it is at least at a 45° angle to the child's trunk (Figure 8f).

Up hand on mat. When the child's up hand crosses over the trunk and contacts the mat on the down side of the trunk (Figure 8g).

Both shoulders off the mat. When the child raises his trunk so that both shoulders are off the mat (Figure 8h).

Down elbow leaves mat. When the child raises his trunk so that the down elbow left the mat (Figure 8i).

Down ear in line with down hip. When the child raises to a sitting position, the ear on the down side is vertically in line with the top on the down side (Figure 9j).

Down elbow completely straight. When the child is in a sitting position, the down elbow is completely stratight (Figure 8k).

Incorrect response. If the child raises to sitting without using trunk rotation, as in Come to Sit from Supine Using Trunk Flexion, do not count the trial as correct.

Measurement Procedure

Once the child is correctly positioned, attempt to prompt the child into sitting up. Elicit this response using any of the following methods or combinations of them: a verbal instruction; a demonstration of the desired response; or a physical put-through prior to the assessment trials. Each time the child displays one of the responses defined previously, record a plus (+) for that response on the data sheet. Furthermore, each time during a trial a defined response does not occur, mark a minus (-) on the data sheet for that response. At the end of each trial allow the child to rest for 5 to 10 seconds. Run a total of five trials. See Figure 9 for recording responses in the come-to-sit position.

Student ____________________ Examiner ____________________

Date ______________________ Observer ____________________

Phase _____________________ Reliability _________________

____

1. Rotate Head ____

2. Rotate Trunk ____

3. Head OFF Mat ____

4. DOWN Elbow on Mat ____

5. Down Hand On Mat ____

6. Abduct Down Shoulder ______________________________________

7. Up Hand on Mat ____

8. Both Shoulders Off Mat ____________________________________

9. Down Elbow Leaves Mat _____________________________________

10. Down Ear in Line with Hip _________________________________

11. Down Elbow Completely Straight ____________________________

Figure 9. Data Sheet for recording responses in the come-to-sit position.

Come to Sit From Sidelying

Materials and Equipment

Two stopwatches, a data sheet, and floor mat.

Positioning the Child

Use this procedure to assess the child's ability to come to a sitting position from lying on either his left or right side. Make the assessment separately from both sides. Initially place the child in a sidelying position on the mat.

Behavior Definitions

Raise head off mat. The child raises his head off the mat so that the examiner (or observer) can slide a hand under his head (Figure 10a).

Down elbow on mat. The child's *down* elbow contacts the mat (Figure 10b).

Down hand on mat. The child's *down* hand contacts the mat (Figure 10c).

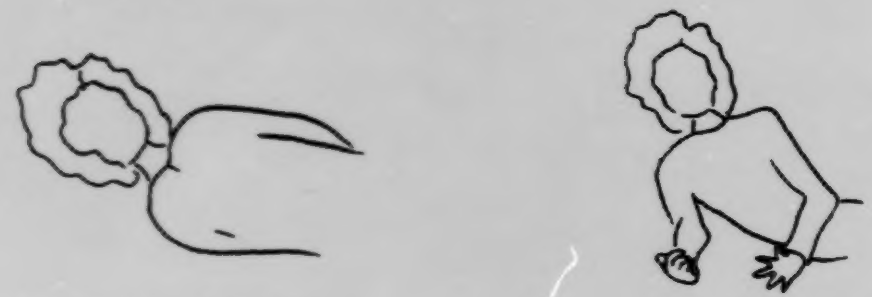
Move down elbow out. The child's *down* arm moves out away from his trunk to at least a 45° angle from the trunk (Figure 10d).

Up hand on mat. The child's *up* hand crosses his trunk and contacts the mat on the *down* side of the trunk (Figure 10e).

Raise down shoulder. The child's *down* shoulder raises off the mat (Figure 10f).

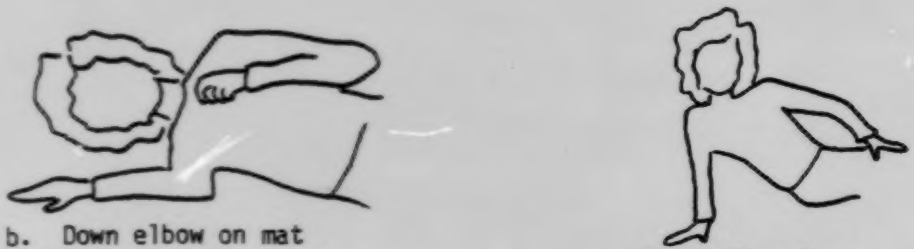
Down elbow leaves mat. The child raises his trunk so that his *down* elbow leaves the mat (Figure 10g).

Down ear in line with hip. When the child raises into a sitting position, the ear on the down side is vertically in line with his hip on the *down* side (Figure 10h).



a. Raise head off mat

f. Raise down shoulder



b. Down elbow on mat
c. Down hand on mat
d. Move elbow out

g. Down elbow leaves mat

e. Up hand on mat

h. Down ear in line with hip
i. Down elbow completely straight

Figure 10. Come to Sit from Sidelying: Illustrations of Responses.

Down elbow completely straight. When the child is in a sitting position, his elbow on the *down* side is completely straight (Figure 10i).

Incorrect response. When the child rolls over into a prone or supine position, and then comes to sit from one of these positions, do not count the trial as correct.

Measurement Procedure

Once the child is correctly positioned, remove all supporting hands from the child and begin the trial. Attempt to elicit the desired response by verbally instructing the child, modeling or demonstrating the desired behaviors, or physically putting the child through the response prior to the assessment trial. Any time one of the defined responses occurs during the trial, record a plus (+) on the data sheet. If no response occurs, record this on the data sheet by marking a minus (-) in the appropriate place on the data sheet for that trial. Between trials allow the child to rest 5 to 10 seconds. Conduct a total of five trials. Refer to Figure 11 for the data sheet used in recording come-to-sit from sidelying position.

Come to Sit From Supine Using Trunk Flexion

Materials and Equipment

Two stopwatches, a data sheet, a floor mat, and the trisectional measuring plexiglass.

Positioning the Child

Place the child in a supine position on the mat. Place the plexiglass parallel to the child with the apex at the child's hip and the angles pointing toward the child's head (Figure 12b).

Behavior Definitions

Head up. The child raises his head off the mat so that the examiner can slide a hand under his head (Figure 12a).

Subject ____________________ Phase ____________________

Date ____________________ Examiner ____________________

Observer ____________________ Reliability ____________________

---

1. Raise Head Off Mat ____________________

2. Down Elbown on Mat ____________________

3. Down Hand on Mat ____________________

4. Abduct Down Arm ____________________

5. Up Hand on Mat ____________________

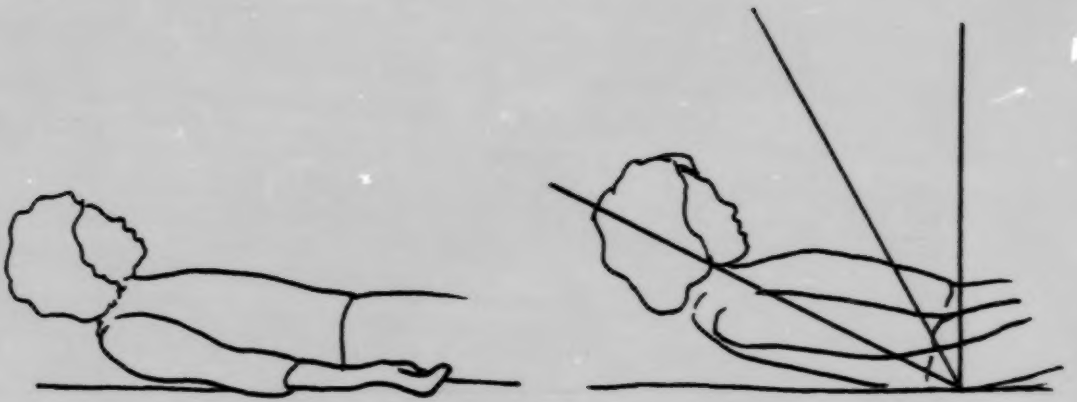
6. Raise Down Shoulder ____________________

7. Down Elbow Leaves Mat ____________________

8. Down Elbow Completely Straight ____________________

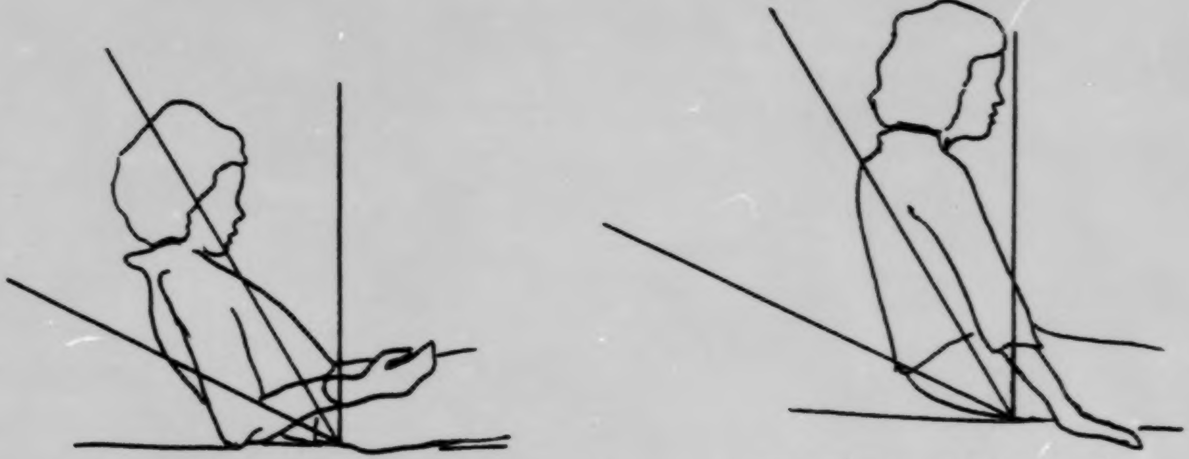
9. Down Ear in Line with Hip ____________________

Figure 11. Data sheet for recording come-to-sit from sidelying position.



a. Head up

b. Shoulder in Trisection 3
c. Extend arm straight



d. Shoulder in Trisection 2
e. Elbow on mat

f. Shoulder in Trisection 2
g. Hand on mat

Figure 12. Come to Sit from Supine using Trunk Flexion: Illustrations of responses.

Shoulders in Trisection 3. The child's shoulders both raise off the mat at the angle measured by Trisection 3 of the plexiglass (Figure 12b).

Shoulders in Trisection 2. The child's shoulders both raise off the mat at the angle measured by Trisection 2 of the plexiglass (Figure 12d).

Shoulders in Trisection 1. The child's shoulders raise off the mat at the angle measured by Trisection 1 of the plexiglass (Figure 12f).

Using one elbow on mat. When the child put one elbow on the mat behind his trunk to assist in raising his trunk off the mat (Figure 12g).

Using two elbows on mat. When the child puts both elbows on the mat behind his trunk to assist in raising his trunk off the mat.

Using one hand on mat. When the child puts one hand on the mat behind his trunk to assist in raising his trunk off the mat (Figure 12g).

Using two hands on mat. When the child puts both hands on the mat behind his trunk to assist in raising his trunk off the mat.

Extend one arm striaght forward. When the child moves both arms forward in front of his body in the process of raising his trunk off the mat.

Incorrect response. If the child's trunk rotates to one side and he comes to sit using trunk rotation do not count the trial as correct.

Measurement Procedures

Once the child is correctly positioned remove all supporting hands from the child and begin the trial. Instruct the child, model or demonstrate the desired response, or physically put the child through the response prior to beginning the assessment trial in order to elicit the desired responses from the child. When the trial begins, observe the child through the plexiglass trisectional device. When the child makes one of the coded responses, record a plus (+) in the appropriate place on the observation sheet. If the child fails to make a response during the

Subject ____________________ Examiner ____________________

Date ____________________ Observer ____________________

Phase ____________________ Reliability ____________________

1. Head up ____________________
2. Shoulder in Trisection 3 ____________________
3. Shoulder in Trisection 2 ____________________
4. Shoulder in Trisection 1 ____________________
5. One elbow on mat ____________________
6. Two elbows on mat ____________________
7. One hand on mat ____________________
8. Two hands on mat ____________________
9. Extend one arm ____________________
10. Extend two arms ____________________

Figure 13. Data sheet for recording responses in the come-to-sit supine using trunk flexion position.

trial, score a minus (-) in the appropriate place on the data sheet. At the completion of each trial, allow the child 5 to 10 sec to rest before starting the next trial. Conduct a total of five trials. See data sheet in Figure 13 for recording responses in the supine position.

Protective Extension to the Side in Sitting

Materials and Equipment

This assessment requires the use of a padded incline mat. The mat must have a slope of 60° to the floor, a width of 4' and a length of 6'. In addition, a felt board 12" x 24" is required. Other required equipment includes a large pillow and appropriate data sheets.

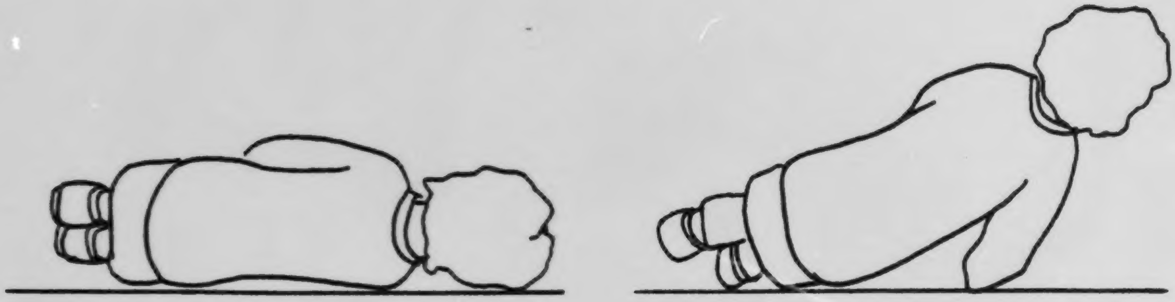
Positioning the Child

The purpose of this assessment is to measure the child's ability to sit back up after he has had is sitting support removed. Place the child on the incline mat in a sitting position so that his right side is lower than his left side. Place the child's hands on his lap. Place a large pillow on the incline mat approximately 12" from the child's right side. This is to protect the child in case of a hard fall. Then place the board next to the child's right side and lean the child's body on the board while holding it stable and at a right angle to the floor.

Behavior Definitions

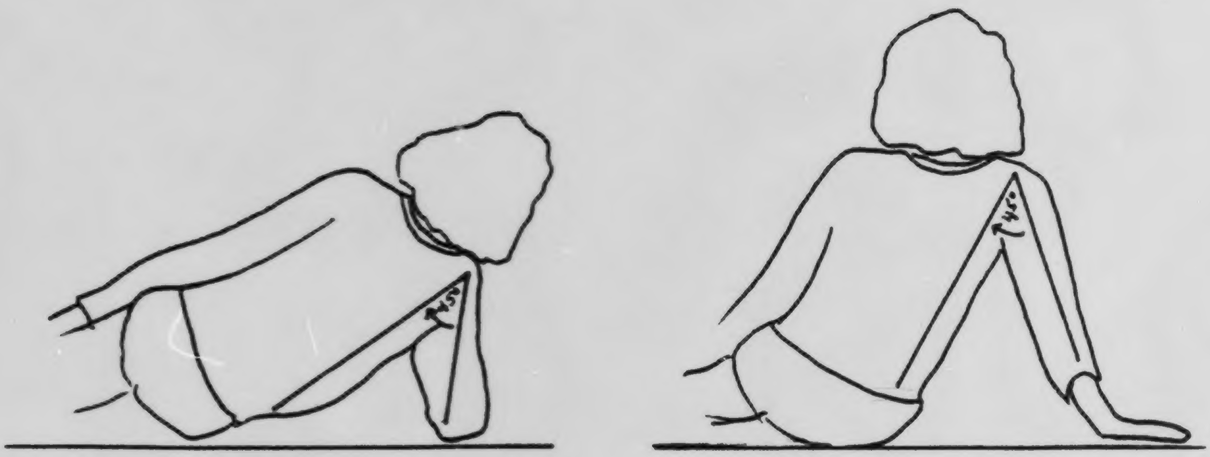
Six types of responses are defined all of which the child may display after the support board is removed. These responses are numbered (instead of labeled) and defined below. All may occur following the removal of the board.

1. The child's body downward and hits the mat without the elbow moving outward. (Note: Do not allow the child's head to strike the mat (Figure 14a).



a. Response 1

b. Response 2



c. Response 3 and 4

Response 5 and 6

Figure 14. Protective Extension to the Sides: Illustrations of responses.

2. The child's elbow moves outward (abduction) and contacts the mat before the rest of the body. The elbow should move out enough so that the examiner can see between the child's elbow and trunk (Figure 14b).

3. The child's elbow moves outward and contacts the mat at a 45° angle to the trunk (at least) before the rest of the body contacts the mat. Once the elbow contacts the mat it is not necessary for the child to maintain the position (Figure 14c).

4. The child's elbow moves outward and contacts the mat. The child maintains this position for the count of "1001, 1002" (Figure 14c).

5. The child's hand moves outward to the mat first at a 45° angle (at least) to the trunk. Once the hand contacts the mat it is not necessary for the child to be able to maintain the position (Figure 14d).

6. The child's hand moves outward to contact the mat before the rest of his body and maintains this position for the count of "1001, 1002" (Figure d14).

Incorrect Responses

Any of the following responses are incorrect:

1. The child moves backward or forward after the board is removed.
2. The child does not move after the board is removed.
3. The child catches himself by grasping a body part or pice of clothing.

Measuring Procedure

Once the child is correctly positioned, begin the trial by quickly removing the board the child is leaning on. Then record the child's responses on the data sheet. If the child makes one of the defined responses, mark this in the appropriate place on the data sheet (Figure

15) using a plus (+) sign. If an incorrect response occurs, the trial is not counted and is repeated. Give the child no more than 5 sec to begin after the board is removed. Allow the child to rest 5 to 10 sec after each trial. Conduct a total of five trials for each side of the child's body (a total of 10 trials over all).

Protective Extension to the Back in Sitting

Materials and Equipment

The same materials that were used to assess protected extension to the side in sitting are needed.

Positioning the Child

This procedure assesses the child's ability to regain a sitting position after falling backwards from a sitting position. Place the child on the incline mat in a sitting position so that his feet are at the higher end of the incline mat and his back at the lower end. Place the child's hands in his lap. Then place the pillow on the mat behind the child's back (this will cushion the child's fall). Next place the board behind the child's back and lean the child against the board (as if it were a chair back) while holding it steady at a right angle to the floor.

Behavior Definitions

Five types of responses are defined any of which the child may . display after the support board is removed. These responses are defined below.

1. The child's body moves downward so that the back or shoulders come into contact with the incline mat without the elbows or hands moving backward to catch the body weight (Figure 16a). (Note: Do not allow the child's head to strike the mat.)

Subject ____________________ Examiner ____________________

Date ____________________ Observer ____________________

Phase ____________________ Reliability ____________________

Trials:	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
Response 1										
Response 2										
Response 3										
Response 4										
Response 5										
Response 6										

Figure 15. Data sheet for recording responses in the protective extension to sides in sitting position.

2. The child's elbow moves backward so that it contacts the mat and is at a 45° angle (at least) to the trunk. Once the elbow contacts the mat it is not necessary for the child to be able to maintain the position (Figure 16b).

3. The child's elbow moves backward so that it contacts the mat and remains in this position for the count of "1001, 1002" (Figure 16c).

4. The child's hand moves backward so that it contacts the mat first at a 45° angle (at least) to the trunk. Once the hand contacts the mat, it is not necessary for the child to maintain his body weight on the hand (Figure 16d).

5. The child's hand moves backward so that it contacts the mat and remains in this position for the count of "1001, 1002" (Figure 16d).

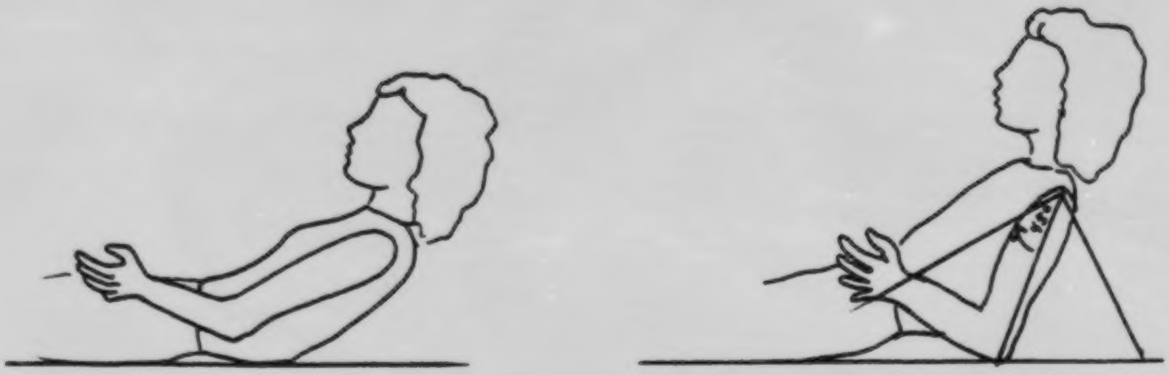
Incorrect Responses

Any of the following responses are considered incorrect.

1. The child moves sideward or to the front after the board is removed.
2. The child doesn't move after the board is removed.
3. The child catches himself by grasping a body part or piece of clothing.

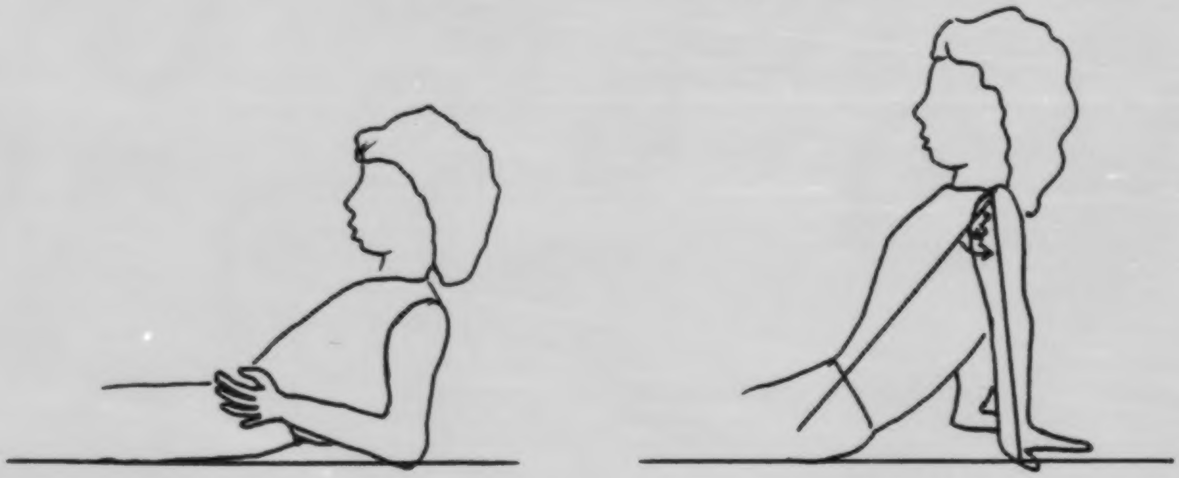
Measurement Procedure

Once the child is correctly positioned, begin the trial by quickly removing the board the child is leaning against. Record the child's response on the data sheet (Figure 17). If the child makes one of the defined responses, mark this in the appropriate place on the data sheet using a plus sign (+). If an incorrect response is displayed, do not count the trial, and repeat it. Give the child no more than 5 sec to begin his response after the board is removed. Allow the child to rest 5 to 10 sec after each trial. Conduct a total of five trials.



a. Response 1

b. Response 2



c. Response 3

d. Response 4 and 5

Figure 16: Protection Extension to the Back in Sitting: Illustrations of Responses.

Subject ______________________ Examiner ______________________

Date ______________________ Observer ______________________

Phase ______________________ Reliability ______________________

	Trials: 1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
Response 1										
Response 2										
Response 3										
Response 4										
Response 5										

Figure 17. Data sheet for recording responses in the protective extension to back in sitting position.

Independent Sitting

Materials and Equipment

The plexiglass trisectional measuring device specified under "Supported Sitting" is required. Two stopwatches, data sheets, and a floor mat are also needed.

Positioning the Child

The purpose of this assessment is to measure the child's ability to sit independently. Place the child in his optimal sitting position on the mat. Set the plexiglass parallel to him with the apex at his hips and the angle lines pointing out toward his feet. While still holding onto the child, straighten his back to assure that he is starting from the most upright sitting position possible.

Behavior Definitions

The child's independent sitting posture is measured using the trisectional measurement defined below.

Trisection 1. The child sits independently with his shoulder closest to the measuring glass between the 90° and 60° angle lines. If his shoulder is centered on the 60° angle line, it is recorded in Trisection 1 (Figure a4).

Trisection 2. The child sits independently with his shoulder closest to the measuring glass between the 60° and 30° angle lines. If his shoulder is centered on the 30° angle line, it is recorded in Trisection 2 (Figure 4b).

Trisection 3. The child sits independently with his shoulder closest to the measuring glass between the 30° and 0° angle line (Figure 4c).

Incorrect independent sitting. When any of the following occur, the child's behavior is incorrect and the trial should be terminated.

1. The child rests his head on his lap, on the measuring glass or anything else.

2. The child supports himself by leaning on an arm, hand, or by grasping something for support (as in Propped Sitting).

3. The child falls sideward or leans laterally 45° or more. (Figure 3a).

Measurement Procedure

Once the child is correctly positioned, begin the trial by releasing the child's back and starting the stopwatch. Observe the child through the plexiglass and every 30 sec record which trisection the child's back is in at that point. Record this information on the data sheet (Figure 18) in the appropriate place. Observe the child for 5 min or until the child falls or makes an incorrect response. If the trial ends before 5 min is up, record the total duration of the trial. If the trial lasts less than 30 sec, record on the data sheet the trisection the child's back was in before the trial ended and the total duration (in number of seconds) of the correct response. Allow the child to rest 5 to 10 sec between trials and conduct a total of five trials. Record the total duration of each trial, and the amount of time the child spends with his back in each trisection (in 30 sec blocks).

Subject ____________________ Examiner ____________________

Date ____________________ Observer ____________________

Phase ____________________ Reliability ____________________

	Tally Time Sample				
	1	2	3	4	5
1. Sitting in first Trisection					
2. Sitting in second Trisection					
3. Sitting in third Trisection					
4. Total Duration					

Figure 18. Data sheet for recording responses in the independent sitting position.

REVIEW OF MEASUREMENT INSTRUMENTS AND PROCEDURES FOR ASSESSING MOBILITY BEHAVIORS: IMPLICATIONS FOR QUANTITATIVE MEASUREMENT

by

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(ECI Document No. 125)
March 1980

Preparation of this paper was partially supported by a grant from the Bureau for the Education of the Handicapped (USOE 300-77-0308).

MOBILITY

This review of the literature was underta[illegible] for the purpose identifying existing information regarding the emergence of mobility skills in infants and young handicapped children. The review of mobility included skills relating to rolling, crawling, creeping and walking. Specific information was sought relating to the documentation of the emergence of mobility skills, the instruments and procedures used to identify and assess these skills, and the research that has been conducted to identify the sequence and ages of the emergence of mobility.

In all of the materials reviewed, the basic references include earlier studies by Gesell (1928), Gesell and Armatruda (1941), McGraw (1940, 1941, 1943), and Shirley (1933). Their previous longitudinal studies in infant development had apparently provided the basis for most if not all subsequent work in the area of mobility.

In this review will be discussed standardized and nonstandardized assessment instruments which assess mobility skills; 2) the developmental milestones of mobility which have been identified and 3) a proposed hierarchy of the emergence and development of mobility skills that represents a sythesis of the literature reviewed.

Standardized Instruments and Checklists

Instruments and developmental checklists were selected for review in this section if they met the following criteria: 1) items were included relating to mobility skills normally developed between the ages of birth to twelve months; 2) mobility behaviors were referenced to a hypotesized sequence of emergence; 3) behaviors included were defined in observable terms; and, 4) the instruments underwent standardization procedures. Each of the instruments was reviewed to determine the specified testing conditions (including settings, materials, time limitations) suggested for implementation, the clarity of the behavioral descriptions, and the scoring procedures utilized. The instruments reviewed were: The Developmental Profile (Alpern and Boll, 1972), The Bayley Scales of Infant Development (Bayley, 1969), The Denver Developmental Screening Test (Frankenburg, Dodds, and Fandal, 1975), The Developmental Schedules (Gesell, 1928; Gesell and Thompson, 1934; and Gesell and Amatruda, 1941), and the Koontz Child Development Program (Koontz, 1974).

Many of the instruments reviewed did not include specifications regarding the physcial environment during the examination or observation period. The Bayley Scales of Infant Development and the Developmental Schedules provided the most information. Included in the Bayley Scales were specifications for the equipment required in positioning the child, suggestions regarding the appearance of the examining room, and the dress of the examiner. The Developmental Schedules included blueprints for special equipment to be used, recommended room arrangements, and appropriate positioning of the child and observer in relationship to the room and to each other. A special emphasis was made by Gesell on the need for the standardization of these procedures. The Denver Developmental Screening Test did not describe any physical conditions required for testing procedures. Similarily, the Development Profile and the Koontz Child Developmental Program did not require the use of particular physical arrangements. (Both of these instruments utilized parental report and observation.)

Most of the manuals for the instruments included at least a brief discussion of the arrangement of the environment to maximize the child's performance during the examination period. The Bayley Scales described a number of suggestions to accomplish this, including assistance by the mother or mother-substitute. The Developmental Schedule described introductory procedures specific to various ages. The Denver Developmental Screening Test briefly discussed the need to make the child comfortable during the examination period and include a few suggestions to accomplish this.

Very detailed procedures were included in the Developmental Schedules for the assessment of individual skills. The sequence of the assessment prescribed depends upon the child's chronological age. Then, for each of the mobility items, instructions were provided regarding what behaviors are to be observed and how to encourage the demonstration of that skill. Each behavior was elicited and observed in a variety of ways dependent on the child's demonstration of behaviors in preceding assessment situations. Suggestions were given for methods of positioning children to maximize performance. The type and placement of "lures" to encourage movement was also discussed.

The Bayley Scales included brief descriptions of the position in which the infant should be placed for each behavior. Sidelying and supine positions were used to assess rolling and the prone position was used to assess crawling and creeping. For standing and walking, the position of the child was not specified. The Denver Developmental Screening Test included specifications for positioning the child for some items; others were scored by report of the parent. The Developmental Profile and the Koontz Child Development Program included conditions in their questions that sometimes specified the desired position of the child to demonstrate the skill; i.e., "...when on a hard surface, on stomach, child will make alternating movements of legs," (Koontz, 1974, p. 8).

While initial positioning of the child was described in most of the behaviors, no suggestions were made regarding the use of an orthosis or prosthesis, or the observations to be made in this situation. No recommendations were noted regarding the degrees of physical assistance in positioning by the examiner and that effect on scoring. In each assessment, creeping behaviors were observed after placing the child in prone; none assessed creeping behavior after the child was placed in a creeping position. Behaviors in all instruments were assessed on flat surfaces such as floors or crib mats. No measures of mobility on incline or carpeted surfaces were recommended.

The only materials described in the assessment of mobility skills were those used to attract the child and to encourage movement. Toys were the most frequent recommendation.

The scoring procedure used by each of the instruments was the recording of the presence or absence of the skill for each item described. In few cases did the behavioral description include a quantifiable specification of when a skill should be considered "present" in terms of duration, latency or rate. The Bayley Scales included only one distance qualification in creeping and crawling; the Developmental Schedules indicated pivoting in prone must be more than 45!. The Koontz Child Development Program qualified standing as "standing unsupported for several seconds". The only qualifications in the Denver Developmental Screening Test were a two and ten second duration measure of unsupported standing, and a five second duration measure of supported standing. No such qualifications were included in the Developmental Profile.

The Developmental Schedules were the most structured of the instruments reviewed in terms of the requirement for the actual observation by the examiner of the assessed behaviors. The Developmental Profile was scored totally by parental reports; the Koontz Child Developmental Program was scored after a minimum of one week of free observation. Both the Denver Developmental Screening Test and the Bayley Scales used a combination of structured examination, observation, and parent report.

Of the instruments reviewed, all except the Denver Developmental Screening Test included all four types of mobility: rolling, crawling, creeping, and walking. The Denver did not include creeping. Differences occurred in the number and kind of observations made for each type of mobility. The more detailed assessments such as the Bayley and Developmental Diagnosis included component behaviors related to each type of mobility, i.e., arm positions related to creeping behaviors. The others did not break down each skill as finely. None of the instruments rated degrees of performance of the task in terms of quality of the movement, e.g., uncoordinated or smooth.

Nonstandardized Instruments and Checklists

Many nonstandardized instruments and checklists are available which also identify and measure the existence of mobility skills. The instruments selected for review were based on the following criteria: 1) they included items related to mobility between the ages of 0-12 months; 2) behaviors were referenced to a hypothesized sequence of emergence; and, 3) behaviors were defined in observable terms. The instruments varied greatly in the clarity of the behavioral definitions, the conditions prescribed for the examining situation, and the materials used. The instruments reviewed were: The Down's Syndrome Inventory (Dmitriev, Note 1), the Developmental Pinpoints (Cohen, Gross and Haring, 1976), The Infant Learning Program Behavioral Repertoire (Gentry, Note 2), The Learning Accomplishment Profile (Sanford, 1974), the Behavioral Characteristics Progression (Santa Cruz County Department of Education, 1973), The Callier Azusa Scale (Stillman, Note 3), the Portage Project Checklist (Shearer, Billingsley, Frohman, Hilliard, Johnson & Shearer, Note 4), and the Project Memphis Checklist (Quick, Little and Campbell, 1974).

Most frequently, the setting for administrating the assessment was less structured than for the standardized instruments. Of the eight instruments included in the review, five used examiner observation. The Developmental Pinpoints, Project Memphis Checklist, and Portage Project Checklists specified that the recording should occur after observation of the child, but the period of observation time was not specified. The Behavioral Characteristics Progression and Callier Azusa recommended classroom observation periods of at least two weeks. The Infant Learning Program Behavioral Repertoire and the Down's Syndrome Inventory employed more formal procedures and utilized contrived settings to assess the skills.

All of the instruments included at least brief descriptions of the procedures used to assess, or the conditions for the observation of, individual skills. The Infant Learning Program Behavioral Repertoire included the most detailed instructions to the examiner regarding the procedures to be used to elicit target responses. Included for each skill were statements regarding the positioning and handling of the child. Particular types of surfaces or furniture were also specified when needed.

The Learning Accomplishment Profile derived all mobility items under one year of age from the Denver Developmental Screening Test, Bayley Scales of Infant Development and Developmental Schedules. As in the original sources, some of the items included directions for positioning the child and observing the responses. Other items were again scored by parental report. The Callier Azusa, Behavioral Characteristics Progression, Portage Checklist and Project Memphis Checklist did not clearly identify the way in which the examinations or observations should be conducted. However, the positioning and materials necessary are easily inferred from the behavioral descriptions, i.e., "on stomach, rolls from side to side" (Stillman, Note 3, p. 11) or "maintains self in a crawling position" (Dmitriev, Note 1, p. 11). For most of the items, it was not anticipated that this lack of specific definitions would pose a major problem. However, it is possible that some of the mobility skills could be performed with the assistance of a person, orthosis, or prosthesis. In most cases no suggestions were made regarding the rating or score to be recorded in such a situation. The exception to this in all assessments is the assistance provided the child in pulling to standing and walking. Additionally the Infant Learning Program Behavioral Repertoire included an item in which creeping is assessed after the child was placed in a hands and knees position.

The scoring procedures used in all of the nonstandardized instruments were occurrence measures. Only the Learning Accomplishment Profile included any quantitative clarifications of items scored. Only "standing alone" and "standing with support" were measured by duration in that instrument. The Developmental Pinpoints, Portage Checklist, Behavioral Characteristics Progression, Callier Azusa, Memphis Checklist and Infant Learning Program Behavioral Repertoire included no such qualifications. Descriptors such as "momentarily," "temporarily" and "briefly" were used.

The instruments reviewed varied greatly in the number of items included to assess mobility skills and the categorization of those items. All, however, assessed the four mobility types of rolling, crawling, crreping, and walking. The Developmental Pinpoints included the largest number of items to assess in the areas of "maintaining static balance and maintaining dynamic balance using basic movement patterns." The Infant Learning Program Behavioral Repertoire included items in "prone progression" and "upright" categories. In addition to assessing rolling, crawling, creeping, and walking, this instrument assessed associated reflexive behaviors, including the asymmetrical tonic neck reflex and the tonic labyrinthine reflex. The Callier Azusa categorized relevant mobility behaviors into "postural control and locomotion." As in the other instruments, the four types of mobility were assessed but additional responses were included in which the exainer was directed to omit "only if the child cannot be expected to exhibit the behavior because of a specific sensory or motor deficit" (Stillman, Note 3, p. 4). The Learning Accomplishment Profile, Down's Syndrome Inventory, Memphis Checklist and Portage Guides arranged the assessment items by age and the Behavioral Characteristics Progression listed the skills in a generally sequential order by age (although no ages were recorded on the form). The number of mobility skills assessed in the instruments reviewed ranged from five in the Memphis Checklist to 41 in the Developmental Pinpoints.

Research in Development of Mobility Skills

Most of the research related to the identification of the sequence of the development of mobility skills occurred between 1920 and 1950. The early work of Gesell seems to have had the largest impact. Frequently referenced norms from Gesell, (Gesell, 1928, 1940; Gesell and Amatruda, 1941; Gesell and Thompson, 1934, 1938) were derived from a study of 107 children. Five hundred and twenty four examinations were conducted at four week intervals during the children's first year of life. Mobility skills were assessed via the Developmental Schedules developed by Gesell. Norms were determined by calculating the percentage of children displaying a behavior at each age level and are reported in Infant Behavior (Gesell and Thompson, 1934). Data were stenographically and cinemagraphically recorded.

Reliability was reported for only prone behaviors. Reliability was calculated by comparing the percentage of occurrence of items for each age level for two different groups of children. Each group of children was assessed by different examiners. Reliability was reported to be 90% or higher for 54% of all items assessed in prone.

Gesell is credited with pioneering use of cinematography to document behaviors in infants. Sixteen millimeter film of mobility behaviors was hand projected, enabling stop-frame analysis of the film to determine duration and topography of individual behaviors. With this procedure Gesell was able to identify and analyze movement of the head, trunk, arms, legs, hands, and feet associated with mobility. Many of these photographs are found in The Atlas of Infant Behavior (Gessel, 1934).

Burnside (1927) used motion picture film to identify the sequence of development of prone progression in individuals and to compare this sequence with the development of others. Particular interest was paid by Burnside to the distance traveled by individuals and the order in which the limbs moved as the child locomoted. Duration of the contact of the hand, knee and foot was determined by counting the number of motion picture frames in which the particular behavior was observed. Burnside reported finding differences in the ages in which crawling, creeping and walking occurred, as well as an increase in coordination of rapidity of movement as the child increases in age.

Shirley (1931) did a longitudinal study of 25 babies during their first two years of life. Data were obtained through daily records by the mothers of the children in the study and by standardized motor tests administered bi-weekly. In the daily recording procedures, mothers were requested to check a developmental skill appearing on the checklist on the first day the particular behavior was demonstrated and to continue checking that item (if it occurred) for two weeks. It was reported that the checked item was included in the study only if the examiner concurred with the parent. No reliability information was reported in this study.

Shirley (1931) has provided detailed reports of other procedures used to quantitatively measure the development of crawling and walking. For the creeping progression, latency and duration of the responses as well as the distance traversed were measured. None were considered to be satisfactory by Shirley. Reasons for this included variations in responses resulting from motivational differences in the children, (i.e., how interested the children were in getting someplace). In the study of how children assume an erect posture, the duration of standing behavior was recorded as well as the latency of getting to a standing position. Beginning with the fifth month of age, weekly and sometimes bi-weekly measures were made of walking behavior by permanently recording foot steps of children. This was accomplished by applying oil to the feet of the children and having them walk across white wrapping paper. The recorded measures included the total number of full foot prints, toe prints, side prints, distance traversed, print sequence, stepping distance, stepping width and stepping angles.

Medians and means for the group at each age level was calculated.

Ames (1937) studies the sequential pattern of the development of prone behaviors. Five children were studied for one year. Motion pictures taken at four week intervals recorded the children's behavior in four situations: in prone; in prone with an immobile, silent lure; in prone with a moving lure; and in prone with social interactions provided. These behaviors were recorded while observing the child on a grid. Through the cinemographic analysis, 14 stages of prone progression were identified and exact timings of movement were identified by the counting of frames of film.

Of the research reviewed McGraw (1941, 1943; McGraw and Breeze, 1941) provided the most detailed analyses of the development of mobility skills. Utilizing cinematography along with other procedures, several studies were completed in the areas of rolling, crawling and creeping, erect locomotion, stepping, and erect posture. For each of the areas, progressions and modal ages were identified. In studying crawling and creeping, McGraw observed 82 infants at weekly and bi-weekly intervals. A total of 1,777 observations were made. Four hundred and twenty-two observations were recorded on motionfilm and 1135 were recorded as written protocol. From the films, detailed drawings of the progressions were prepared to illustrate the topography of these behaviors. Utilizing the observations, the phases of prone progression were identified. Descriptions of each phase were provided by McGraw and are summarized in Figure 1. These phases were organized into data sheets enabling observers to record the presence or absence of overt behaviors related to the prone progression. The data were summarized by computing the percentage of occurrence for each phase for 10 day intervals at each chronological age level. The resulting data showed the range of emergence, completion of the phase, and corresponding modal chronological ages. Reliability data were obtained after the initial observations were completed by McGraw. A series of films were shown to groups of 13 and 42 observers. The films showed 31 different behaviors of infants. The reliability coefficient for the 13 observers was 84.4% and 75.5% for the group of 42.

Three thousand, three hundred and eight-seven observations were made of eighty-two children by McGraw and Breeze (1941) to determine the sequence of the development of the assumption of erect posture and walking. The ages of the children studied ranged from a few months to eight years old. Through the same method described previously various stages were identified. They are summarized in Figures 2 and 3.

A Newborn - characterized by total body flexion, face resting on surface, occassional head bobbing, flexed upper and lower extremties.

B Beginning Spinal Extension - baby lifts head for a while less flexion shown in upper extremeties.

C Advanced Spinal Extension - baby lifts head and chest, supports self on arms.

D Incipient Propulsion in Superiod Region - demonstrates attempts to move by extended arm forward.

E Incipient Propulsion in Inferior Region - baby raises hips by extending legs.

F Assumption of Creeping Posture - baby maintains abdomen in a raised position.

G Deliverate but Unorganized Progression - movement forward but not smooth.

H Organized Progress - smooth coordinated movements forward.

I Integrated Progression - demonstrates synchronization of left arm/ right leg movements.

FIGURE 1. MCGRAW'S PRONE PROGRESSION

Adapted from McGraw, M. Development of neuro-muscular mechanics in the crawling and creeping behavior of the human infant. Journal of Genetic Psychology, 1941, 58, 83-111.

A Newborn or reflex stepping - general flexion, organized stepping.

B Inhibition or Static Phase - no demonstration of stepping.

C Transition - more movement of body, stamping of feet, stamping possibly reflexive.

D Deliberate Stepping - maintains a more erect position, stepping provoked by infant's hands held and support provided under arms.

E Independent Stepping - independent walking, gait wide, movements exaggerated.

F Heel - toe progression - steps become heal forward, foot strikes the surface as back foot is raised on toes.

G Integreation or Maturity of Erect Locomotion - synchoronous swinging of each arm coordinated with movement of opposite lower extremity.

FIGURE 2. MCGRAW'S STEPPING PROGRESSION

Adapted from McGraw, M., and Breeze, K. Quantitative studies in the development of erect locomotion. Child Development, 1941, 12, 267-304.

A Passive Phase - passive to attempts to be pulled to standing.

B Extensor-Thrust Phase - attempts to stand when pulled to sitting.

C Orthotonic Phase - attains semi-erect position when pulled to sitting.

D Vertical Posture Phase - attains erect position when pulled to standing.

E Vertical Push Phase - attins erect position by holding on to furniture.

F Independent Rising Phase - awkwardly raises to erect position from floor.

G Integrated Phase - attains standing position from floor with coordinated movements.

FIGURE 3. MCGRAW'S ASSUMPTION OF AN ERECT POSTURE

Adapted from McGraw, M. Neuromuscular development of the human infant as exemplified in the achievement of erect locomotion. Journal of Pediatrics, 1940, 17, 747-771.

Developmental Sequence of Mobility

The literature relating to mobility was reviewed to identify behaviors leading to the emergence of mobility and the sequence of the emergence of those behaviors. The intent was to identify a sequence of behavior that was observable and could be assessed by quantitative measures.

Utilizing information obtained from assessment instruments (both standardized and nonstandardized) and developmental research, it was possible to identify 1) mobility behaviors; 2) behaviors preceding mobility; and; 3) ages ascribed to those behaviors. Behaviors and corresponding ages (when given) were recorded on individual index cards. The cards were then sorted by the four general types of mobility - rolling, crawling, creeping and walking. By analyzing the grouping of cards in each category, it became evident that within each group several subcategories were present. Those subcategories were: 1) movement into the position required for that type of mobility, i.e., child assumes all four positions; 2) stability in the position, i.e., child maintains all four positions for a period of time; 3) movement in the position, i.e., child rocks in all four positions; 4) locomotion in the position, i.e., child creeps; and, 5) movement out of the position, i.e., child goes from all four positions to prone. For each type of mobility the behaviors were similarly subcategorized.

Each category and subcategory was then reviewed with regard to the ages referenced. Each behavior was found to be identified with a range of ages, both within and among the various sources. For the purpose of summarizing this information, ages were used that represented the modal age identified by the sources reviewed.

A hierarchy was then constructed including only observable behaviors associated with mobility. Each type of mobility was arranged horizontally by the sequence in which the behaviors would be expected to be observed in a competent locomotor. The behaviors are arranged vertically by the age range of emergence. The mobility hierarchies can be viewed in Figures 4, 5, 6, & 7.

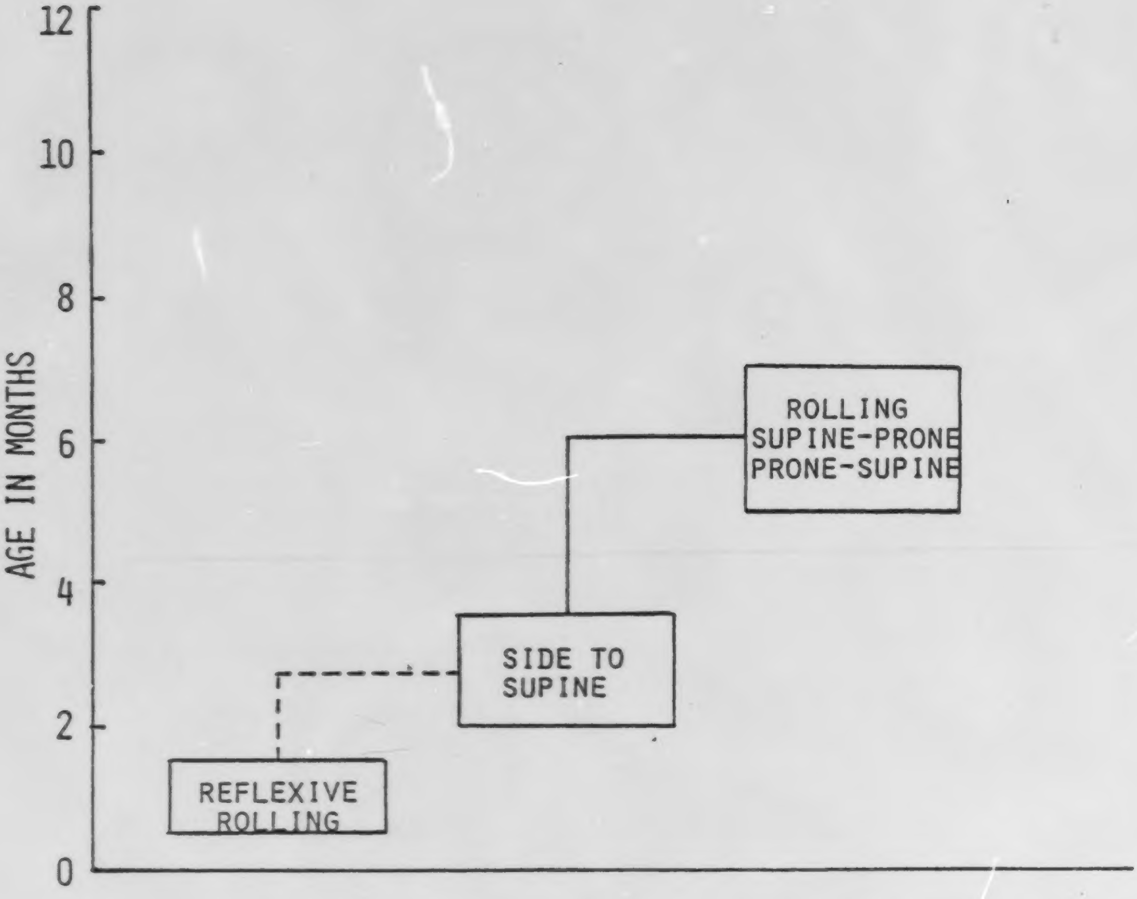


Figure 4. Rolling Progression

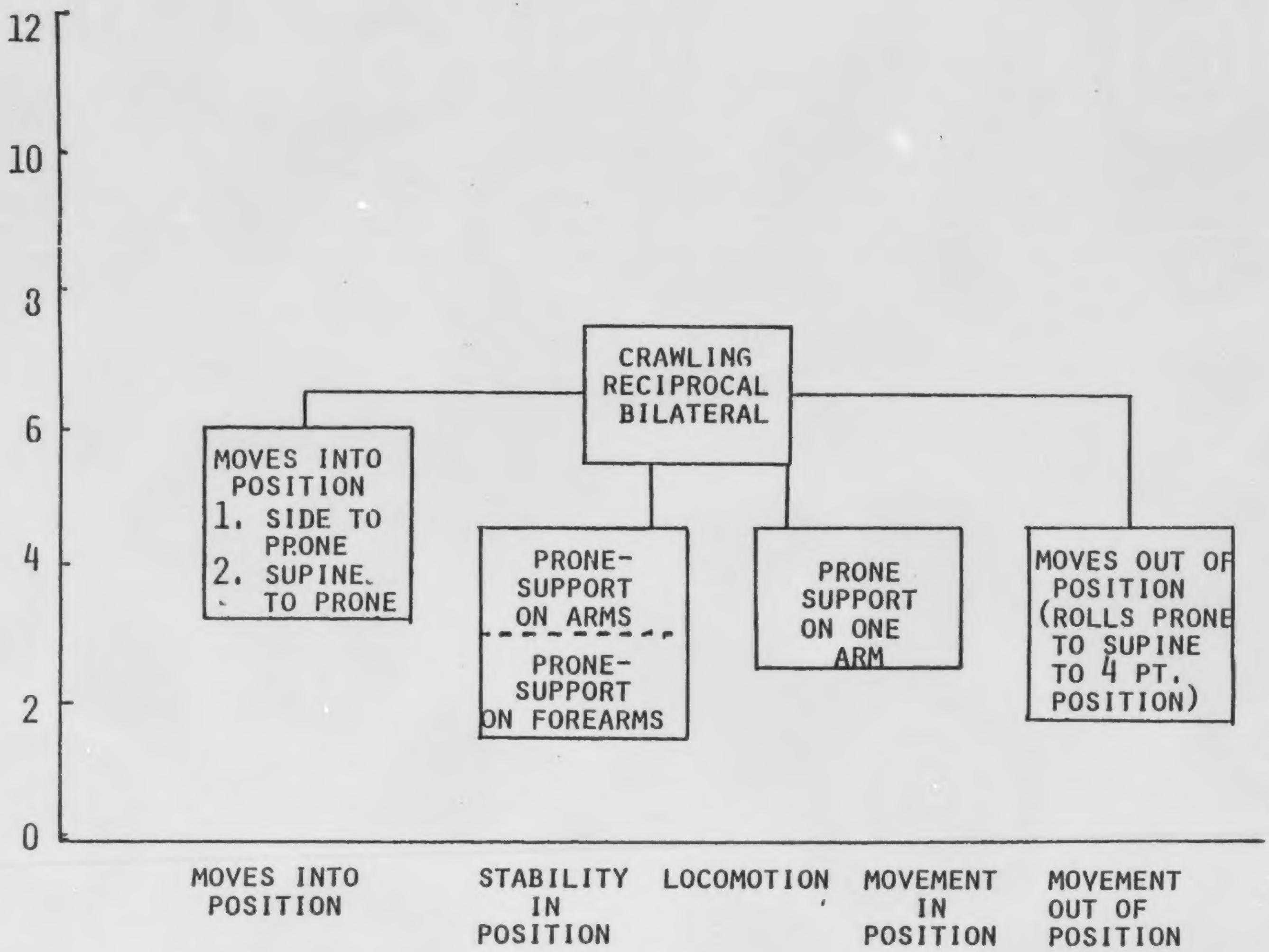

12
10
8
6
4
2
0
CRAWLING RECIPROCAL BILATERAL
MOVES INTO POSITION
1. SIDE TO PRONE
2. SUPINE TO PRONE
PRONE-SUPPORT ON ARMS
PRONE-SUPPORT ON FOREARMS
PRONE SUPPORT ON ONE ARM
MOVES OUT OF POSITION (ROLLS PRONE TO SUPINE TO 4 PT. POSITION)
MOVES INTO POSITION
STABILITY IN POSITION
LOCOMOTION
MOVEMENT IN POSITION
MOVEMENT OUT OF POSITION

Figure 5. Crawling Progression.

M20

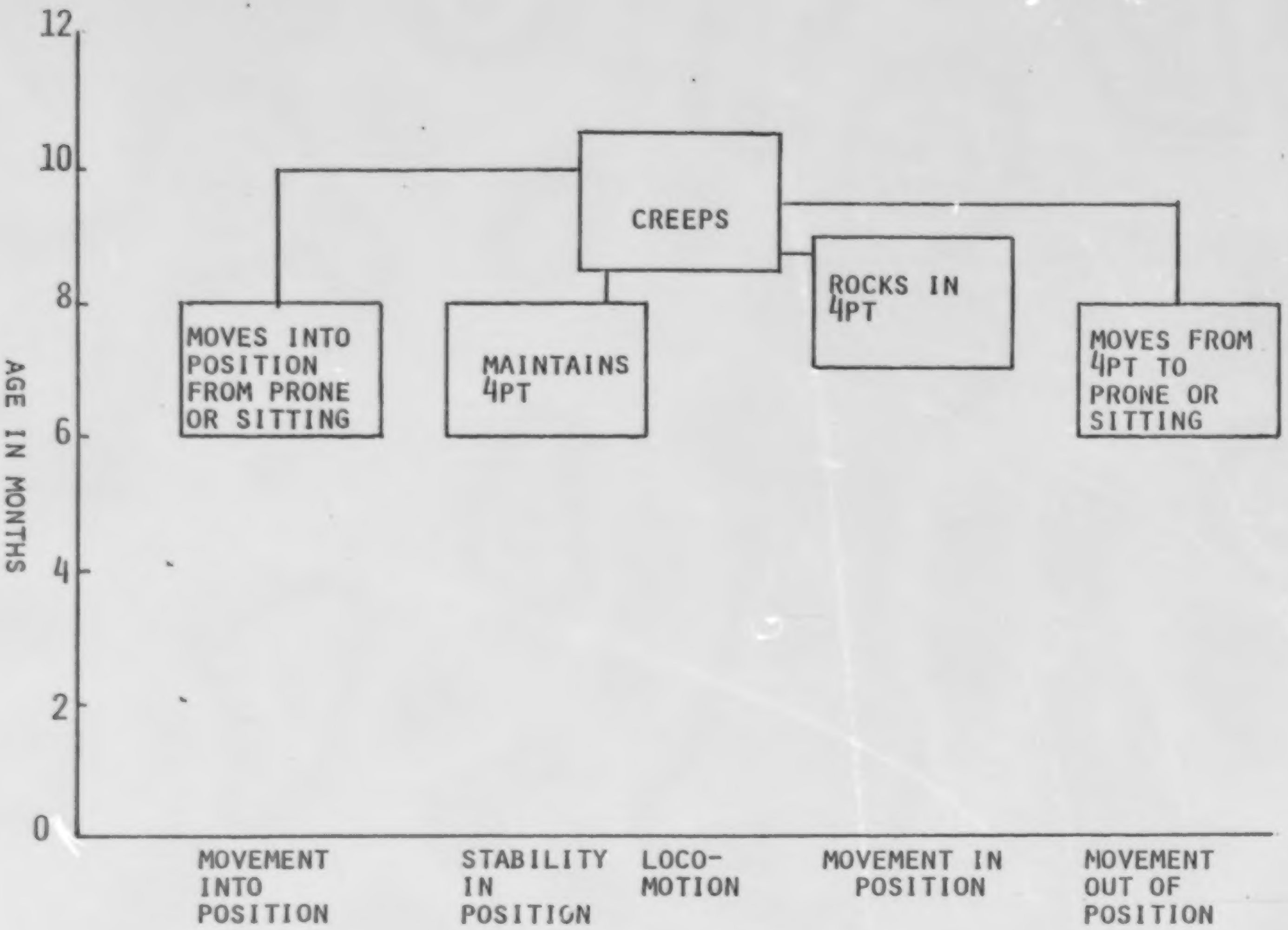
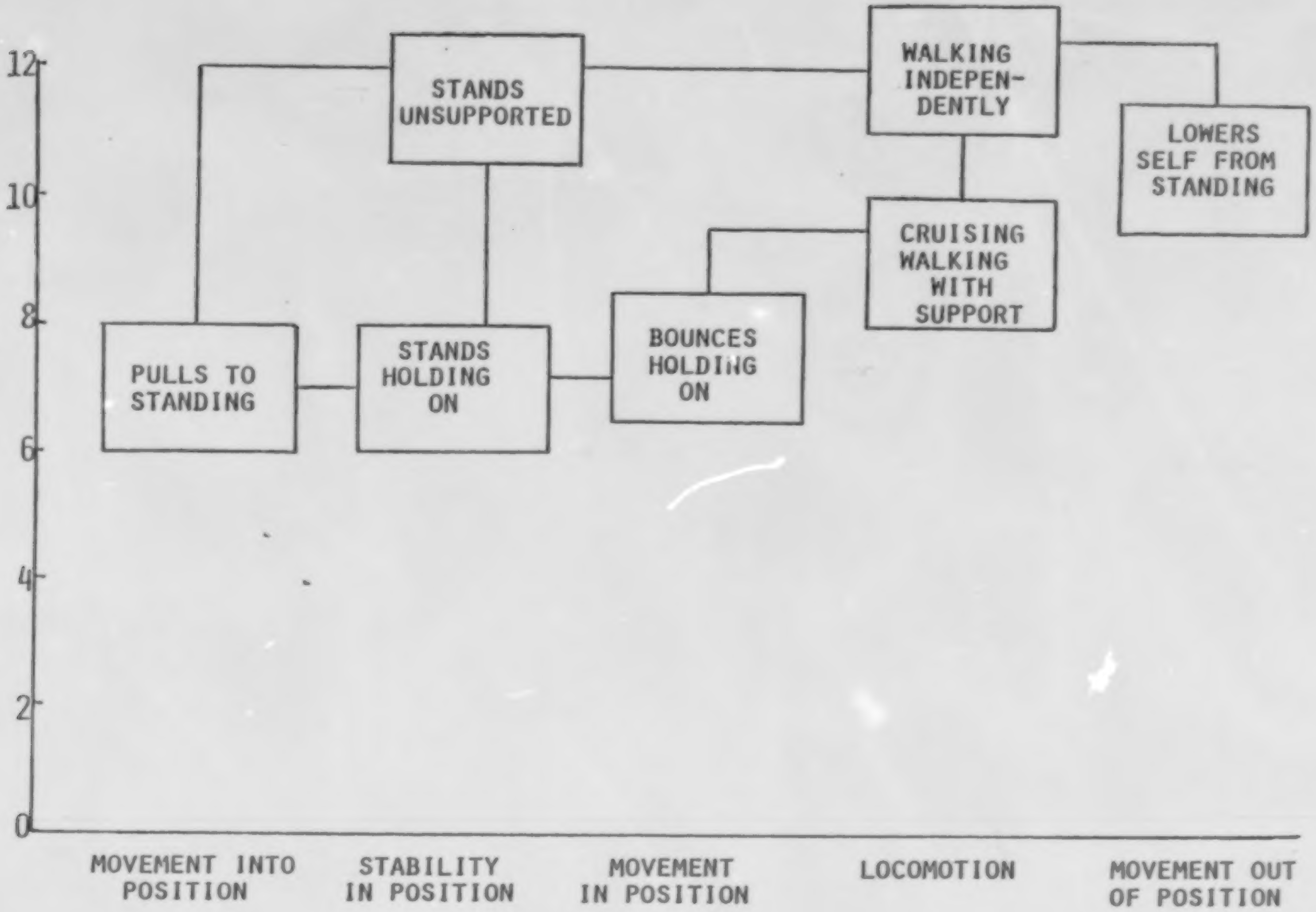


Figure 6. Creeping Progression.

Figure 7. Walking Progression.

M22



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Mobility

Procedures for Measuring Segmental Rolling

by

Paula Day[1], Jane Rues and Donna Lehr

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[1] The procedures reported in this study were taken, in part from a master's thesis conducted by Paula Day that was submitted to the Department of Special Education at the University of Kansas in 1980.

Selecting the Target Behaviors

Information obtained from the assessment instruments and developmental research was used to identify descriptors of rolling behaviors that were amenable to quantitative measurement procedures. It has been clearly shown that rolling progresses through several stages. As Gessell (1934) noted an infant's first step towards the achievement of an erect posture is through the use of rotational components during rolling. All current assessments lack any clear measurement of the emergence of rolling. Specific scales define rolling as the ability to roll independently from a supine to a prone position. By limiting their measurement to the absolute of nonoccurrence or occurrence, these scales have little value in identifying the emergence of rolling or its variuos component stages.

In order to effectively determine the stage of development in rolling behavior for a child, target behaviors were selected that measured the various components of rolling. These target behaviors are segmental rolling from a supine, prone and sidelying positioning and rolling mobility.

Developing the Measurement and Observation Procedures

Emergence, quality and mobility aspects of rolling is discussed according to seven major headings: (a) Specification of Behavior; (b) Materials and Equipment; (c) Observational Settings; (d) Conditions for Observing; (e) Providing Cues to the Child; (f) Measuring Rolling; and (g) Specification for Taking Measures of Reliability.

The Specification of Behavior section provides a description of the behavior to be measured and the types of measurement procedures utilized.

The Materials and Equipment section includes the materials needed for the child and those required by the observer to measure the behavior. When applicable, information is given on how the materials should be arranged in the environment.

The Observational Settings section specifies the locations for administration of the assessment.

The Conditions for Observing section provides descriptions of the initial positioning procedures of the child as well as other positioning procedures used in the assessment. Specifications for observer positioning are also described.

The section titled, Providing Cues to the Child, defines not only what cues to use, but how and when they should be presented.

The section on Measuring Rolling includes definitions of rolling and other terms related to these behaviors. There is a more detailed explanation in this section of the type of recording procedures used as well as descriptions for the beginning and ending of a trial.

The Specification for Taking Measures of Reliability section provides criteria for reliability measures as well as information on how reliability measures are taken and calculated. The formula for determining the agreement among observers is included.

Measuring Segmental Rolling in Prone, Supine and Sidelying Positions

Specification of Behavior

In the positions of prone, supine and sidelying the child's response is observed and then recorded in terms of the following: 1) degrees of independent rolling, 2) degrees of trunk rotation, and 3) duration of movement.

Materials and Equipment

A data sheet (Figure 1), pencil, stopwatch and reinforcing objects are used. A carpeted floor area, free of obstacles is required. Additionally the preparation and use of the following additional equipment is required.

Rolling Prone to Supine
Supine to Prone

Name:

Examiner:

Date:

Observer:

Observation Length:

Reliability:

Descriptors:

P - prone position
S - supine position
SL- sidelying position

R - right
L - left
A - verbal
B - visual

Trial	Initial Position	Stimulus Direction	Degrees Body Rotation	Degrees Rolled	Duration	Reliability
1	P	R				
2	P	R				
3	P	R				
4	P	L				
5	P	L				
6	P	L				
7	S	R				
8	S	R				
9	S	R				
10	S	L				
11	S	L				
12	S	L				
13	SL R	P				
14	SL R	S				
15	SL L	P				
16	SL L	S				

Figure 1. Rolling Data Sheet.

Elastic Band #1. Cut a three-inch wide elastic strip to a length of one-half inch longer than the measurement of the child's hips (positioned directly below the umbilicus). First, place a mark one-fourth inch from each end of the elastic strip. Then divide the remaining band into four equal sections by color coding each quadrant. The quadrants are further divided into two equal parts by drawing a single black line (See Figure 2a).

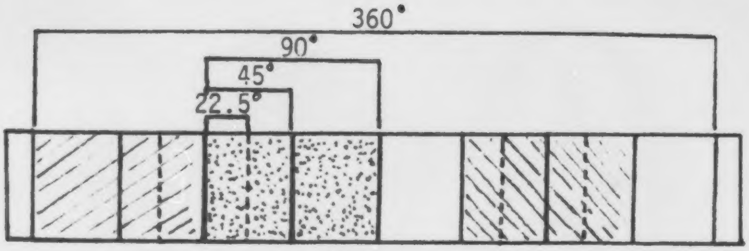
The inside quadrants of red and blue and outside quadrants of white and green are further divided into equal parts by black dotted lines. The elastic strip is then sewn together one-fourth inch from raw edges to form a circular band. Each colored section represents 90°, the dividing line in each section indicates 45° and the dotted sections represent 22.5°. The total band represents 360° (See Figure 2b).

Elastic Band #2. Cut a one-inch wide strip of elastic to a length of one-half inch longer than the measurement around the child's chest (using the mipple line as a reference point). Divide the elastic strip and construct the band following the directions for Band #1.

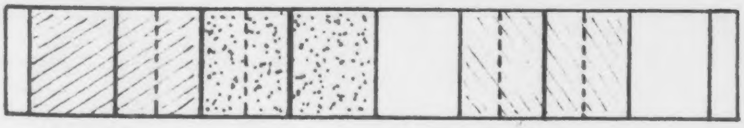
The examiner should identify preferred toys for each child. Parents usually can provide this information. If no information is available, the examiner should present a variety of objects and observe the child to determine if the items are preferred. The child may demonstrate preference for an object by looking at it, reaching for it, etc.

Some examples of commonly reinforcing agents and how they are used are: visually interesting toys with bright colors and moving parts can be used to stimulate the child to visually follow the object.

Auditorily stimulating toys such as music boxes, bells, etc. are used to encourage rolling by allowing the child to visually follow the adults face or roll toward a preferred person.


360°
90°
45°
22.5°

a. Elastic strip 1



b. Elastic strip 2

red ▨

green ▒

blue ▧

Figure 2. Elastic Band #1 and #2

Observational Settings

The measurements should be taken in a structured situation where the child's degrees of rolling and body rotation can easily be observed. These can occur either at home or at school. The child needs to be viually and/or socially alert.

The structured observation setting employed a second examiner who provided visual or auditory stimulation by holding interesting objects to the side and above the child's head to encourage rolling.

Conditions for Observing Segmental Rolling in Supine

Initial Positioning Procedures. The child is placed on his back with head in midline and trunk straight. The elastic bands are positioned comfortably around the child as seen in Figure 3. Place child in a supine, prone or sidelying position and slip the band around his hips and chest. Positioning of the Band #1 needs to be directly below the umbilicus with the bands seam centered on the umbilicus. Band #2 should be directly over the nipple line and corresponding to colors in Band #1. The bands should be tight enough to remain securely in position but not so tight as to create or constraint movement or cause discomfort.

Positioning Procedures. In the supine position, six trials are taken, 3 to the child's right side and three to the child's left side. Once the child was positioned and bands correctly placed, the trials would begin procedure for each trial consisted of the following steps:

1) Begin stopwatch.
2) The examiner says or signs "roll", then gains the child's attention by moving toy in visual field to designate side.
3) Observe trunk rotation by noting difference in band markings. Stationary band versus moving band.

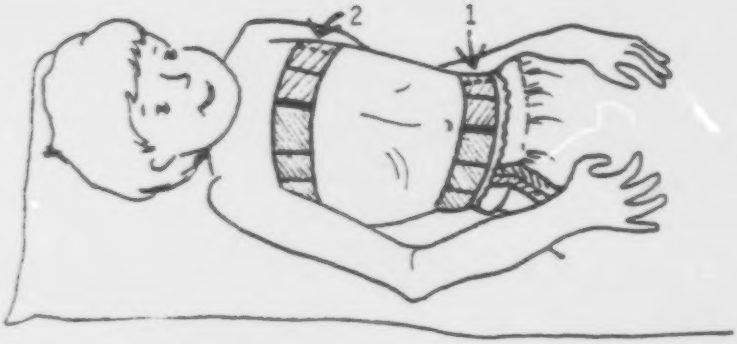


Figure 3. Positioning of Bands 1 and 2.

4) Periodically activate toy and verbally encourage child to roll.

5) Stop timing if no movement occurs after 30 seconds.

6) If child makes any movement, timing is countinued until he rolls to either prone or rolls back to supine. A child who rolls to sidelying from supine but then retuns to the supine position will be given credit for rolling to sidelying or 90°.

7) If child independently rolls he is reinforced with verbal praise and a brief opportunity to play with the toy.

8) Observations are then recorded according to descriptions previously defined.

Providing Cue to the Child

Additional data sheet descriptors that require further explanation are the use of prompts. Two prompts can be used simultaneously. The verbal cue "roll" and visual and/or auditory stimulus were used to encourage rolling. These are recorded on the data sheet as A (verbal) or B (visual) or A and B. The presentation of the stimulus are specified for each trials on the data sheet. In the prone position if a stimulus direction was designated as right this indicated the toy was initially held on the child's right side and slightly above his head to encourage rolling.

Measuring Segmental Rolling in Supine Position

After presentation of the stimulus (on child's right or left side, depending on corresponding trial number) observations are made on degrees of independent rolling and degrees of trunk rotation. The degree a child independently rolls is measured by observer Band #1. The side of the child was designated as the initial reference point. If a child rolls from supine to sidelying. This would represent 90° of independent rolling. Rolling from supine to prone equals 180° and rolling from supine to supine would equal 360°. The colored bands help to visualize and measure smaller increments of independent rolling.

To observe and measure the degrees of trunk rotation, the examiner needs to look at both bands and observe the difference in alignment between the stationary and moving body part. Again, the initial reference point is the side. For example, if the child initiates rolling through his left hip by flexing left leg over his trunk and allowing the rest of his body (shoulders and head) to follow, the moving body part would be the left hip (band #1) and the stationary body part being the shoulders (band #2). During this rolling behavior the examiner would observe a distinct difference in alignment between the bands, the white section of band #1 (moving part) would be corresponding to the blue section of band #2 (stationary part). (See Figure 4). The measurement of degrees would be determined by how far the moving band differed from the stationary band. If the white section of band #1 moved to the dotted line a representation of 225° of body rotation would be indicated. If rotation continued and the white section moved to the solid black line, 45° of body rotation would be noted.

The greatest amount of rotation noted during a single trial is recorded.

A duration measure is recorded following each trial.

Conditions for Observing Segmental Rolling in Prone

Initial Positioning Procedures. The child is placed on his stomach with head in midline and trunk straight. The elastic bands are positioned comfortably around the child and in accordance with previous descriptions.

Positioning Procedures. In the supine position, six trials are taken, three to the child's right side and three to the child's left side. Once the child was positioned and bands correctly placed, the trials would

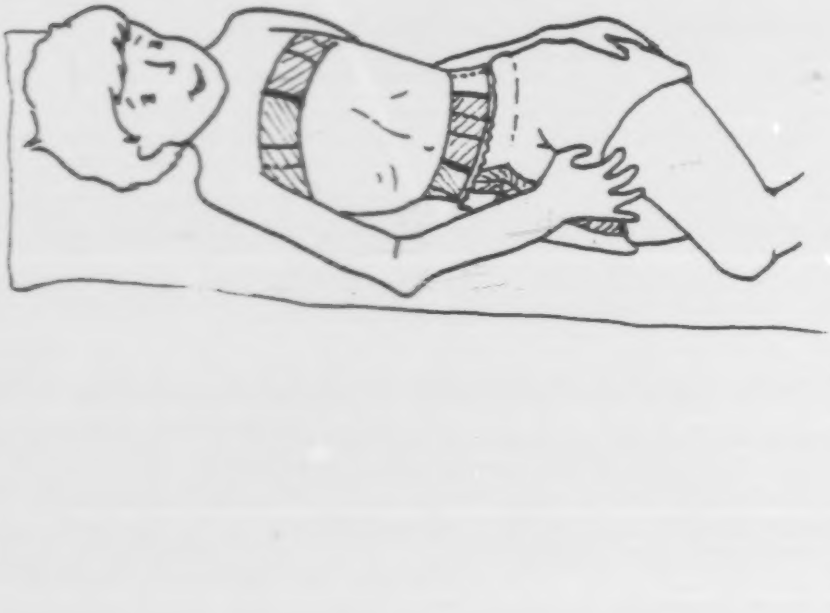


Figure 4 . Observation of rotation.

begin procedure for each trial consisted of the following steps:

2) The examiner says or signs "roll", then gains the child's attention by moving toy in visual field to designate side.

3) Observe trunk rotation by noting difference in band markings. Stationary band versus moving band.

4) Periodically activate toy and verbally encourage child to roll.

5) Stop timing if no movement occurs after 30 seconds.

6) If child makes any movement, timing is countinued until he rolls to either prone or rolls back to supine. A child who rolls to sidelying from supine but then retuns to the supine position will be given credit for rolling to sidelying or 90°.

7) If child independently rolls he is reinforced with verbal praise and a brief opportunity to play with the toy.

8) Observations are then recorded according to descriptions previously defined.

Measuring Segmental Rolling in Prone

After presentation of the stimulus (on child's right or left side, depending on corresponding trial number) observations are made on degrees of independent rolling and degrees of trunk rotation. The degree a child independently rolls is measured by observing Band #1. The side of the child was designated as the initial reference point. If a child rolls from supine to sidelying. This would represent 90° of independent rolling. Rolling from supine to prone equals 180° and rolling from supine to supine would equal 360°. The colored bands help to visualize and measure smaller increments of independent rolling.

To observe and measure the degrees of trunk rotation, the examiner needs to look at both bands and observe the difference in alignment between the stationary and moving body part. Again, the initial reference point being the side. For example, if the child initiates rolling through his left hip by flexing left leg over his trunk and allowing the rest of his body (shoulders and head) to follow, the moving body part would be the left hip (Band #1) and the stationary body part being the shoulders (Band #2). During this rolling behavior the examiner would observe a distinct difference in alignment between the bands, the white section of Band #1 (moving part) would be corresponding to the blue section of Band #2 (stationary part). (See Figure 3). The measurement of degrees would be determined by how far the moving band differed from the stationary band. If the white section of Band #1 moved to the dotted line a representation of 225° of body rotation would be indicated. If rotation continued and the white section moved to the solid black line, 45° of body rotation would be noted. The greatest amount of rotation noted during a single trial is recorded. A duration measure is recorded following each trial.

Measuring Segmental Rolling Sidelying

After presentation of the stimulus (on child's right or left side, depending on corresponding trial number) observations are made on degrees of independent rolling and degrees of trunk rotation. The degree a child independently rolls is measured by observing Band #1. The side of the child was designated as the initial reference point. If a child rolls from supine to sidelying. This would represent 90° of independent rolling. Rolling from supine to prone equals 180° and rolling from supine to supine would equal 360°. The colored bands help to visualize and measure smaller increments of independent rolling.

To observe and measure the degree of trunk rotation, the examiner needs to look at both hands and observe the difference in alignment between the stationary and moving body part. Again, the inital reference point being the side. For example, if the child initiates rolling through his left hip by flexing left leg over his trunk and allowing the rest of his body (shoulders and head) to follow, the moving body part would be the left hip (Band #1) and the stationary body part being the shoulders (Band #2). During this rolling behavior the examiner would observe a distinct difference in alignment between the bands, the white section of Band #1 (moving part) would be corresponding to the blue section of Band #2 (stationary part) (See Figure 4). The measurement of degrees would be determined by how far the moving band differed from the stationary band. If the white section of Band #1 moved to the dotted line a representation of 225° of body rotation would indicated. If rotation continued and the white section moved to the solid black line, 45° of body rotation would be noted. The greatest amount of rotation noted during a single trial is recorded. A duration measure is recorded following each trial.

Conditions for Observing Segmental Rolling in Sidelying

Initial Positioning Procedures. The child is positioned on his right or left side depending on the trial number. In the initial sidelying position the child's head should be slightly flexed forward with trunk straight. The elastic bands are positioned comfortably around the child in accordance with previous descriptors. Once a trial begins repositioning should not be necessary.

Positioning Procedures. In the sidelying position, trials are 2 in the prone position and 2 in the supine position (1 on left side and 1 on right side). Continue to follow same procedures as outlined for the supine position.

Specification for Taking Measures of Reliability

Movement recordings. Reliability percentages for the degrees of body rotation, degrees independently rolled and time elapsed from the start to the end of each trial are recorded separately. Measures of duration are considered in agreement if scores are within five seconds of each other. For each session across all trials, the number of agreements and the number of disagreements for the three categories are tallied, using the following formula to determine reliability scores:

$$\frac{\#\text{ of agreements}}{\#\text{ of agreements and disagreements}} \text{ X100}$$

Calculating the mean reliability scores for each session consists of adding the reliability percentages for each trial and dividing by the total number of trials.

Measuring Rolling Mobility

Specification of Behavior

Measurement of rolling mobility, which is rolling prone to supine and supine to prone as a means of locomotion, consists of recording the number of complete rolls and maximum degrees of body rotation. The distance the child travels as well as the time it takes to travel are also measured.

Materials and Equipment

The two elastic bands used to measure segmental rolling are employed for rolling mobility. In addition to the bands distance markings need to be established. For this procedure masking tape approximately three feet long is needed for a starting point as well as a stopping point. The first piece of tape is placed on the floor or mat and the second piece is applied 10 feet from the starting point. A third piece of tape is then placed horizontal between the two vertical strips (See Figure 5). The horizontal piece of tape is marked at six inch increments for accurate distance measurements.

Similar objects, toys, or food used for segmental rolling may be utilized.

A stopwatch, data sheet for "Rolling Mobility" (Figure 6), and a pencil are the other required items.

Observation Setting

The measurement for rolling mobility should be taken in a structured situation where the childs' frequency of complete rolls and degrees of body rotation can easily be observed. The child needs to be visually and/or socially alert. Also, if the child cries or seizures during a trial, the trial should be discontinued and resumed later. Once a trial begins re-positioning should not be necessary.

The structured observation setting employes a second examiner who provides visual or auditory stimulation by holding interesting objects to the childs side.

Condition for Observing Rolling Mobility

If the child independently rolls both from prone to supine and supine to prone in any of the trails on the data sheet "Rolling Prone to Supine-Supine to Prone" then data should be taken on rolling mobility.

Positioning procedures. The child is positioned in either the prone or supine position which have been specified on the

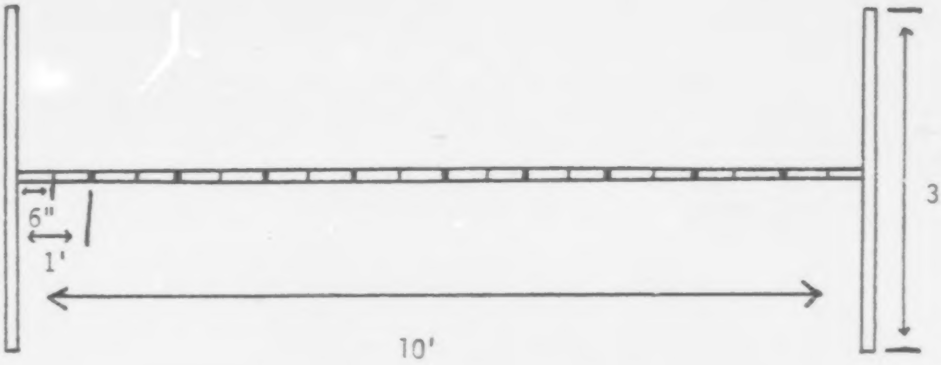


Figure 5. Distance Markers.

Rolling Mobility

Name:

Examiner:

Date:

Observer:

Observation Length:

Reliability:

Descriptors:

P - prone position
S - supine position
SL- sidelying position

R - right
L - left

Trial	Initial Position	Direction of Roll	# of Complete Rolls	Duration	Degrees of Body Rotation	Distance Rolled	Reliability
1	P	R					
2	P	R					
3	P	L					
4	P	L					
5	S	R					
6	S	R					
7	S	L					
8	S	L					
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							

Figure 6. Rolling Mobility Data Sheet

350

data sheet. Specification of the initial position includes the direction of the roll. For example when administering Trial #1 the child is placed in the prone position with the right shoulder resting on the starting tape (Figure 7). The direction of the roll is defined as the arm over which the child initially rolls.

Position of observer. The observer is positioned on either side of the horizontal piece of tape. The most beneficial position is to kneel or stand up so that measures are easily visable.

Providing Cues to the Child

The only cues utilized to encourage rolling are visually, auditorily or, tactily stimulating objects or toys which are presumed to be reinforcing to the child. The item(s) selected is/are placed 2-3 feet from the child and are activated throughout the trial. If the child progresses forward toward the item(s), then the item(s) is/are placed further away until the two minute trial is completed.

Measuring Rolling Mobiltiy

Description of the behavior. Rolling mobility is defined as a complete 360° roll from either the supine or prone position.

Type of measurement used. The type and frequency of rolling is procured by recording the degrees of body rotation and the number of complete rolls.

When recording the number of complete rolls the observer counts one complete roll if the child rolls from either supine to supine or prone to prone, depending on the initial psotion. Partial credit is also measured. For example, if the child initially begins a trial in the supine position and rolls as follows: supine-prone-supine-prone

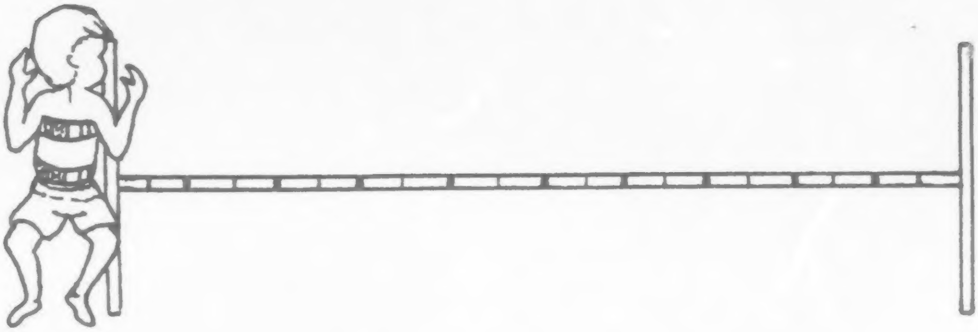


Figure 7. Initial position.

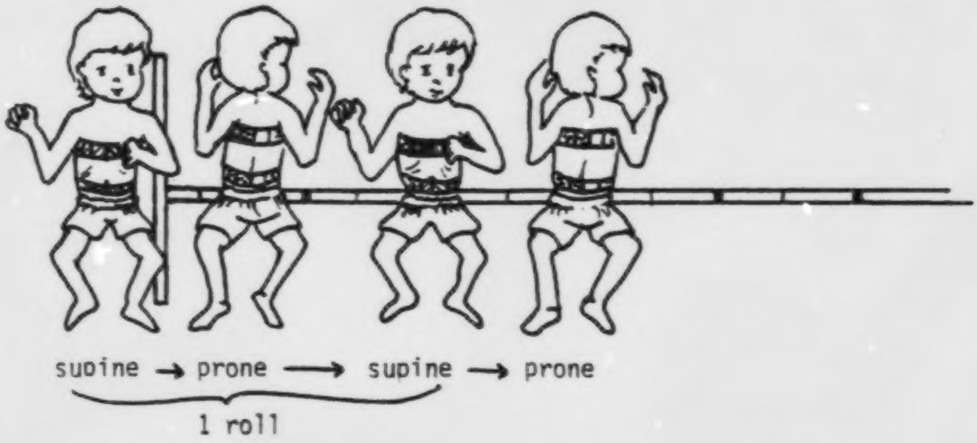
then his total number of complete rolls for the trial would be one and one half (see Figure 8).

The degrees of body rotation is measured as indicated in the segmental rolling procedures by observing the difference in alignment between the stationary and moving bands (Figure 9). The largest amount of degrees noted during a single trial is the recorded measure. For instance, if a child independently rolls three times during a trail with the first roll showing 0° body rotation, second roll 22.5° body rotation and the third roll with 45° of body rotation, the 45° measure would be recorded.

The distance the child rolls is also recorded on the data sheet. The observer places a piece of tape adjacent to the shoulder resting on the starting tape prior to beginning the trial. After the trial is terminated a second piece of tape is placed adjacent to the shoulder furtherest from the starting point. The observer determines the distance traveled by measuring the distance between these two points marked by tape (Figure10).

The time needed to travel the distance of six feet is recorded on the data sheet. However, if the child does not travel six feet, then two minutes (the total length of trial) is recorded in the time column. After the distance traveled and duration have been determined then the rate of locomotion is calculated by dividing the distance traveled by the time.

Beginning of trial. The child is positioned either in prone or supine with the predetermined direction established. After the child is initially positioned measurement commences with the presentation of preferred objects or toys. The stopwatch begins at the same time.


supine → prone → supine → prone
1 roll

rolling: supine-prone-supine-prone

scored: 1½ total rolls

Figure 8. Counting rolls.

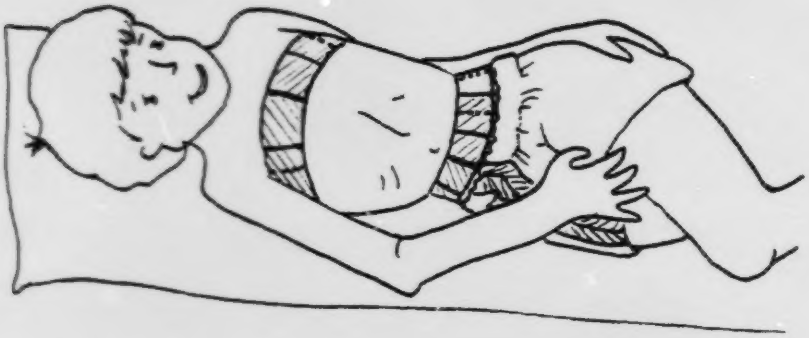


Figure 9. Measuring degrees of rotation.

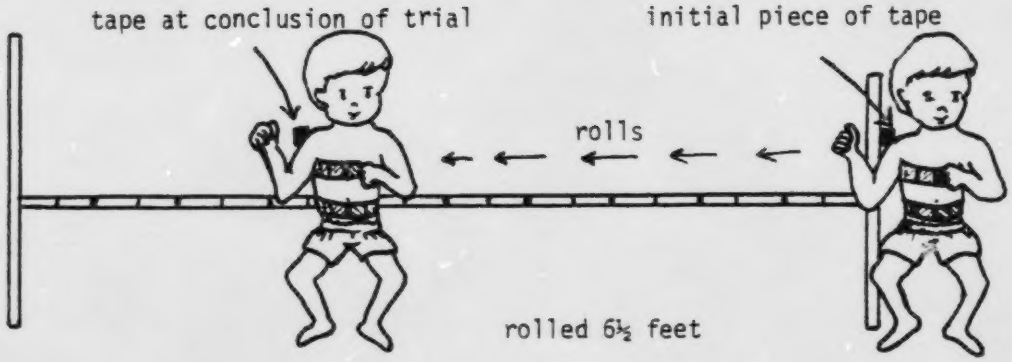

tape at conclusion of trial
initial piece of tape
rolls
rolled 6½ feet

Figure 10. Measuring distance.

Termination of trial. The end of the trial is determined when the child travels the distance of six feet or at the expiration of two minutes, whichever comes first.

Specifications for Taking Measures of Reliability

Reliability precentage for the number of complete rolls, degrees of body rotation, distance rolled and time elapsed from the beginning to the end of each trial are recorded separately. The initial position and direction of the roll are specified on the data sheet. Measures of duration are considered in agreement if the scores are within 5 seconds of each other. For each session across all trials, the number of agreements and the number of disagreements for the four categories are tallied, using the following formula to determine reliability scores:

$$\frac{\text{\# of agreements}}{\text{\# of agreements and disagreements}} \times 100$$

Calculating the mean reliability scores for each session consists of adding the reliability percentages for each trial and dividing by the total number of trials.

MOBILITY

Procedures for Measuring Crawling and Creeping

by

Kathy Kremer[1], Donna Lehr and Karen Leitner

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[1] The procedures reported in this study were taken, in part from a master's thesis conducted by Kathy Kremer that was submitted to the Department of Special Education at the University of Kansas in November, 1979.

Selecting the Target Behaviors

Crawling and creeping behaviors were selected because they are early forms of locomotion usually observed prior to walking. They are behaviors which integrates earlier forms of behavior, and one which many believe to be fundamental to more advanced activities. When considering the severely, multiply handicapped population, crawling and/or creeping may be the only functional means of independent locomotion available to a child. In view of these characteristics, an assessment that measures behaviors quantitatively might provide not only accurate information concerning the transition from crawling to creeping, but also provide a teacher or therapist with a sensitive tool to measure the progress within a child. The latter condition is so desparately needed in assessing the severely, multiply handicapped children because of the small amounts of progress achieved at one time.

In order to determine what types of measurements and descriptions of crawling and creeping behavior were currently available, standardized and nonstandardized assessments were reviewed. From this review, discrete behaviors relating to crawling and creeping were selected and operationally defined so that quantitative measures could be adapted. These behaviors included maintanence, movement and locomotion in both of these positions.

Developing the Measurement and Observation Procedures

Maintenance, movement and locomotion in the crawling and creeping positions is discussed according to seven major headings: (a) Specification of Behavior; (b) Materials and Equipment; (c) Observational Settings;

(d) Conditions for Observing; (e) Providing Cues to the Child: (f) Measuring Crawling and Creeping; and (g) Specification for Taking Measures of Reliability.

The Specification of Behavior section provides a description of the behavior to be measured and the types of measurement procedures utilized.

The Materials and Equipment section includes the materials needed for the child and those required by the observer to measure the behavior. When applicable, information is given on how the materials should be arranged in the environment.

The Observational Settings section specifies the locations for administration of the assessment.

The Conditions for Observing section provides descriptions of the initial positioning procedures of the child as well as other positioning procedures used in the assessment. Specifications for observer positioning are also described. An explanation in the use of the Assessment Administration Chart is included in this section.

The section titled, Providing Cues to the Child, defines not only what cues to use, but how and when they should be presented.

The section on Measuring Crawling and Creeping includes definitions of crawling and creeping and other terms related to these behaviors. There is a more detailed explanation in this section of the type of recording procedures used as well as descriptions for the beginning and ending of a trial. Finally, a summary of the assessment procedures is outlined.

The Specification for Taking Measures of Reliability section provides criteria for reliability measures as well as information on how reliability measures are taken and calculated. The formula for determining the agreement among observers is included.

Measuring Maintenance in the Crawling/Creeping Position

Specification of Behavior

Sustaining of a crawling or creeping position is the emphasis of the first measurement of creeping behavior. Maintenance can occur when the child sustains a static position, but there are other situations that lend themselves to measuring maintenance in the crawling or creeping position. When the child rocks or locomotes, the child is also maintaining the position, and therefore measures are also taken on maintenance in the position while these behaviors are occurring. The measures taken for maintenance in the position consist of coding the position of the arms and the legs every ten seconds, as well as obtaining a measure of the length of time the child remains in the crawling and/or creeping position.

Materials and Equipment

A mat or rug is required, the length determined by the size of the child. The mat or rug should be long enough to accomodate those children who are locomoting and not simply maintaining the position. The minimum length should be ten to twelve feet so that after the child is positioned on the rug or mat, there is at least ten feet of extra space for the child to move. The rug or mat should be positioned next to a wall giving the child less opportunity to wander off a straight path. Although this is highly recommended, it is not considered necessary since it may be difficult to adopt in some environments. A piece of masking tape, approximately three feet long is placed on the floor, a few feet from the edge of the rug or mat. It is to be used as a starting point for the child.

Edibles or stimulating visual, auditory, or tactile toys and objects are usually required to motivate the child to assume a crawling or creeping position. The specific items selected, maniputable or consumable, will depend on the individual child's interests and physical handicaps. Parents and teachers may be asked for suggestions on preferred items of the children. The observer may use his own discretion as to what may be motivating to the child.

Two 2½ inch circular tabs cut from cardbordbpard and marked "L" for left and "R" for right are covered with contact paper. These tabs are placed on the appropriate sides and half way down the child's back with masking tape. They are positioned so the the observer who is standing in front of the child can read them frontwards (see Figure 2).

A tape recorder and tape are required. On the tape should be recorded the numbers "1, 2, 3 . . . 12", spaced be ten second intervals, resulting in a total of a two minute time period. However, for the measurement of maintenance of crawling and creeping behaviors, only a one minute time period is needed. Therefore, during this measurement procedure the tape recorder is stopped after the number six has been stated.

The data sheet for "Maintenance in the Position" (see Figure 3) for crawling and creeping, the Assessment Administration Chart (see Figure 4), and a pencil are the other needed items for measuring this behavior.

Observational Settings

Observations for maintaining the position can take place in a structured setting where the major concern is measuring the maintenance of the crawling and creeping positions. These structured settings may be either in the home or at school in the classroom or other school locations.

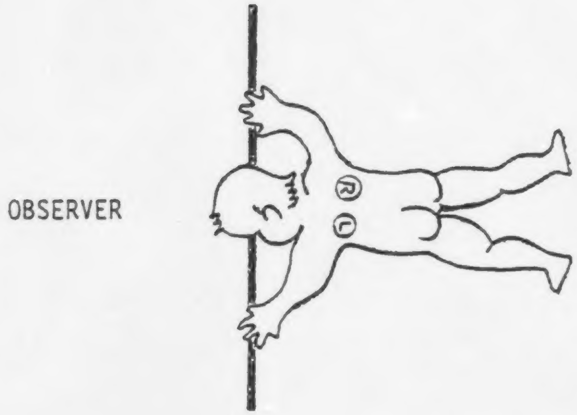

OBSERVER
R
L

Figure 2. Position of the "L" and "R" tabs on the child.

Conditions for Observing Maintenance

Initial positioning procedures. This assessment is devised so that initially all subjects are placed in a prone position on the rug or mat for the first three trials. The arms should be out from underneath the child and free to move. The hands are placed on either side of the head on the starting tape so that the tape is approximately in the middle of the hand. The legs are also extended out from underneath the child. Figure 5 illustrates this initial position.

Positioning procedures. The child is positioned at the beginning of each trial according to the cues being used. Cues 1, 2, and 3 require a prone position while cue 4 requires that a child be placed in the crawl or creep position. If there is no response on the first three trials in which the child is placed in a prone position, then the child is put into a crawling position. This is accomplished by placing the child on his stomach on the floor with his elbows flexed and hands placed on either side of the head. The child's legs are extended, abducted and externally rotated. (See Figure 4, Steps 1A and 2). After the child has been assessed for this behavior, then the child is placed in the creeping position (cue 4), in order to give the child an opportunity to demonstrate this behavior (see Figure 4, Steps 1A, 2, and 4). This position is obtained by placing the child on hands and knees with the arms extended down and the legs flexed down. These positions are further described in a later section. If the child's response for the first three trials is crawling, he must also be given the opportunity to creep, and therefore the child is positioned for creeping on the next three trials (see Figure 4, Steps 1A and 3).

NAME________________ DATE________________

OBSERVER 1________________ OBSERVER 2________________

LOCATION________________ RELIABILITY________________

TRIAL	OBSERV.	CUE	POSITION				DURATION	RELIAB.
			LEGS		ARMS			
			L	R	L	R		
1	1							
	2							
	3							
	4							
	5							
	6							
2	1							
	2							
	3							
	4							
	5							
	6							
3	1							
	2							
	3							
	4							
	5							
	6							
4	1							
	2							
	3							
	4							
	5							
	6							

CUES

1 = OBJECT, TOY, FOOD
2 = DEMONSTRATION
3 = PROMPT
4 = PUT THROUGH

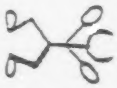
CODE FOR POSITIONS

ARMS: CRAWLING AND CREEPING

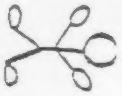
L = PROPS ON FOREARMS
V = PROPS ON ELBOWS
| = ARM EXTENDED DOWN
+ = NO ARM SUPPORT
O = ARM OUT OF POSITION
X = ABNORMAL TONE

LEGS: CRAWLING

V = LEG FLEXED OUT - PASSIVE
Ⓥ = LEG FLEXED OUT - ACTIVE



— = LEG EXTENDED - PASSIVE
⊖ = LEG EXTENDED - ACTIVE



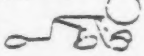
L = LEG FLEXED UP

O = LEG OUT OF POSITION
X = ABNORMAL TONE

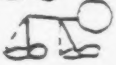
LEGS: CREEPING

⅃ = KNEE FLEXED DOWN

˥ = KNEE FLEXED UP



| = LEG EXTENDED DOWN



+ = NO LEG SUPPORT
O = OUT OF POSITION
X = ABNORMAL TONE

Figure 3. Data Sheet , Maintenance in the Position.

TRIAL	OBSERV.	CUE	POSITION				DURATION	RELIAB.
			LEGS		ARMS			
			L	R	L	R		
5	1							
	2							
	3							
	4							
	5							
	6							
6	1							
	2							
	3							
	4							
	5							
	6							
7	1							
	2							
	3							
	4							
	5							
	6							

TRIAL	OBSERV.	CUE	POSITION				DURATION	RELIAB.
			LEGS		ARMS			
			L	R	L	R		
8	1							
	2							
	3							
	4							
	5							
	6							
9	1							
	2							
	3							
	4							
	5							
	6							

CUES

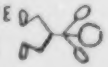
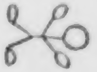
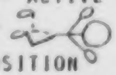
1 = OBJECT, TOY, FOOD
2 = DEMONSTRATION
3 = PROMPT
4 = PUT THROUGH

CODE FOR POSITIONS

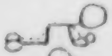
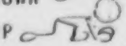
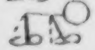
ARMS: CRAWLING AND CREEPING

L = PROPS ON FOREARMS
V = PROPS ON ELBOWS
| = ARM EXTENDED DOWN
+ = NO ARM SUPPORT
0 = ARM OUT OF POSITION
X = ABNORMAL TONE

LEGS: CRAWLING

V = LEG FLEXED OUT - PASSIVE
Ⓥ = LEG FLEXED OUT - ACTIVE

— = LEG EXTENDED - PASSIVE
⊖ = LEG EXTENDED - ACTIVE

L = LEG FLEXED UP 
0 = LEG OUT OF POSITION
X = ABNORMAL TONE

LEGS: CREEPING

⅃ = KNEE FLEXED DOWN 
˥ = KNEE FLEXED UP 
| = LEG EXTENDED DOWN 
+ = NO LEG SUPPORT
0 = OUT OF POSITION
X = ABNORMAL TONE

ASSESSMENT ADMINISTRATION CHART

STEP	DATA SHEET	TRIALS	BEHAVIOR TO ASSESS	CUES	CHILD RESPONSE	"✓" BEHAV.	NEXT STEP
1	1	1, 2, 3	Crawl or Creep	1, 2, 3	A) No maintenance in crawl or creep positions		2
					B) Maintain crawl position		3
					C) Maintain creep position		7
2	1	4, 5, 6	Crawling	4	A) No maintenance in crawl position		4
					B) Maintain crawl position		4
3	1	4, 5, 6	Creeping	4	A) No maintenance in creep position		5
					B) Maintain creep position		5
4	1	7, 8, 9	Creeping	4	A) No maintenance in creep position		If previous response was 2A — STOP If previous response was 2B — 6
					B) Maintain creep position		If previous response was 2A — 8 If previous response was 2B — 6
5	2	1, 2, 3	Crawling	1, 2, 3	A) Crawl rate < .1 step/sec.		If previous response was 3A — STOP If previous response was 3B — 9
					B) Crawl rate ≥ .1 step/sec.		If previous response was 3A — 10 If previous response was 3B — 9
6	2	1, 2, 3	Crawling	4	A) Crawl rate < .1 step/sec.		If previous response was 4A — STOP If previous response was 4B — 9
					B) Crawl rate ≥ .1 step/sec.		If previous response was 4A — 11 If previous response was 4B — 9
7	2	1, 2, 3	Creeping	1, 2, 3	A) Creep rate < .13 step/sec.		STOP
					B) Creep rate ≥ .13 step/sec.		12
8	2	1, 2, 3	Creeping	4	A) Creep rate < .13 step/sec.		STOP
					B) Creep rate ≥ .13 step/sec.		13

(continued)

Figure 4. Assessment Administration Chart.

Assessment Administration Chart (cont.)

STEP	DATA SHEET	TRIALS	BEHAVIOR TO ASSESS	CUES	CHILD RESPONSE	"✓" BEHAV.	NEXT STEP
9	2	4, 5, 6	Crawling	4	A) Creep rate < .13 step/sec.		If previous response was 5A — STOP If previous response was 5B — 10 If previous response was 6A — STOP If previous response was 6B — 11
					B) Creep rate ≥ .13 step/sec.		If previous response was 5A — 13 If previous response was 5B — 10 If previous response was 6A — 13 If previous response was 6B — 11
10	3	1, 2, 3	Crawling	1, 2, 3			If previous response was 5A — STOP If previous response was 9A — STOP If previous response was 9B — 14
11	3	1, 2, 3	Crawling	4			If previous response was 6B — STOP If previous response was 9A — STOP If previous response was 9B — 14
12	3	1, 2, 3	Creeping	1, 2, 3			STOP
13	3	1, 2, 3	Creeping	4			STOP
14	3	4, 5, 6	Creeping	4			STOP

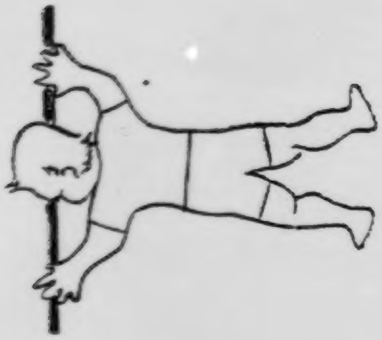


Figure 5. Initial positioning of the child-prone with hands on tape

The child is repositioned, if after three consecutive observations, the child demonstrates behaviors defined as "out of position" or "abnormal tone". To reposition the child, the observer puts the child back into the initial position.

The Assessment Administration Chart (see Figure 4) illustrates the positioning and cueing procedures for administering this assessment. It outlines teacher and student behavior throughout the entire assessment. For all the trials on every data sheet, the chart includes all the possible cues and child responses that could occur during the assessment of crawling and creeping. It should be noted that for every behavior and corresponding cue used, it is assessed for at least three trials before moving to the next step. The child's response on three trials will determine the next step of the assessment.

The procedure for using the Assessment Administration Chart begins with Step 1. Data Sheet 1 is used and responses of the child determines the behavior that will be assessed. Since cues 1, 2, or 3 are used, the child is placed in the prone position. In this position, the child may respond one of three ways: (a) by not maintaining the crawling or creeping position; (b) by maintaining the crawling position; or (c) by maintaining the creeping position. The observer checks in the " Behavior" column which response was observed and then proceeds to the next step as indicated by the chart. By checking the box relating to the child's response, the observer can more easily refer back to the previous response demonstrated, which is necessary for some steps, e.g., Step 4. In Step 4, once the observer checks the appropriate box describing the demonstrated response, a decision must be made as to what response was previously observed. This decision is made by referring to the last mark checked on the chart, and then continuing with the next step. It is not necessary to commit to memorization the sequential process of what behavior to assess and what cue to use for each trial provided the observer checks the response demonstrated by the child and follows the sequential step.

Position of observer. After positioning the child, the observer moves a few feet directly in front of the child in order to present the stimulus objects, toys, or foods in an attempt to coax the child forward. The observer may sit on the back of the legs or knees to allow for a better view of the child's arms and legs, as well as the labels placed on the back of the child. This position enables the observer to move more quickly up or down if necessary.

Providing Cues to the Child

There are a total of four different cues which may be utilized in order to attain a crawling or creeping response from the child. They are coded on the data sheet as follows:

1. Object, toy, food. This includes any visually, auditorily, tactiley stimulating object or toy which is presumed to be reinforcing to the child. The item(s) selected is/are placed three to five feet from the child and are activated throughout the trial. If the child progresses forward toward the item(s), then the item(s) is/are placed further away until the one minute trial is completed.
2. Demonstration. The observer assumes the crawling or creeping position, depending on what behavior the observer is assessing. For creeping, the observer positions himself on hands and knees.
3. Prompt. The observer lightly lifts the child at the shoulders or hips no more than two inches off the ground.

4. Put through. The observer physically puts the child into a crawling or creeping position.

Figure 4 again illustrates the sequence for presenting cues. For the first three trials, cue 1 is usually presented first, unless the observer perceives that the child will not respond or it is observed that the child is not responding. Then, cues 2 and 3 may be attempted. The three cues may then be presented randomly throughout the trial until the child demonstrates a crawling or creeping response. After the child assumes the position, the observer attempts to assist the child in maintaining the position by continuously presenting the object, toy, or food and by repeating any other cue (demonstration or prompt) used. During this time, the observer also provides continuous oral or signed communication. If the child fails to maintain either position due to abnormal tone or falling out of the position for three consecutive observations, then the child is placed in the position used at the beginning of the trial and the previously used cues are presented again until the child assumes a crawling or creeping position or until the end of the trial.

If the observer is unfamiliar with the child, all three cues may be tried during the one minute trial in order to obtain a response. If the observer is fairly acquainted with the child and can suspect which of the three cues the child will respond to, the other cues may not be necessary unless the child is not responding to the assumed eliciting stimuli. However, if the observer perceives that the child may not respond to the first three cues, but only to the fourth cue, the put through, the first three must be tried in order to give the child an opportunity to demonstrate an independent or semi-independent response.

If the child does not demonstrate a crawling or creeping response to the object, toy or food, the demonstration or prompt, then a put through is used to obtain a crawling response for three trials. The put through, cue 4, is used again in the following three trials to assess creeping behavior (see Figure 4, Steps 1A, 2, and 4).

Measuring Crawling and Creeping Maintainance

Description of the behavior. The definitions for crawling and creeping are broad to include any possible variations of this behavior. Crawling is defined as the stomach and hips touching the support surface while the chest, nipples and above are raised from the surface. The child may use forearms, elbows or hands to support himself and the legs may be extended or flexed. Creeping is defined as the trunk, from the neck to the abdomen, being elevated from the floor with the hips having observable flexion. Crawling and creeping may be observed to include various positions of the arms and legs as described in the following terms and illustrations. Therefore, the data sheet (see Figure 3 is devised so that each leg and each arm position is coded separately.

Arm positions:

Props on forearm. The arm is bent at the elbow so that the lower arm (which includes elbow to hand) is in contact with the supporting surface (see Figure 6a).

Props on elbow. The arm is flexed at the elbow so that only the elbow is in contact with the supporting surface (see Figure 6b).

Arm extended. The arm is straight or flexed so that only the hand is in contact with the supporting surface (see Figure 6c).

No arm support. No part of the arm bears weight due to physical limitations such as paralysis.

Arm out of position. Several conditions warrant use of this code. They include:

1. In crawling, the arm is bent out to the side with any part of the upper arm touching the surface (see Figure 7a).
2. In crawling, the arm is straight out in any direction with the forearm touching the surface (see Figure 7b).
3. In crawling, the upper arm is touching the lower arm (see Figure 7c).
4. The arm is in the air (see Figure 7d).
5. Child is sidelying, sidesitting, sitting up, supine, prone with chest and head on floor, or kneeling up.

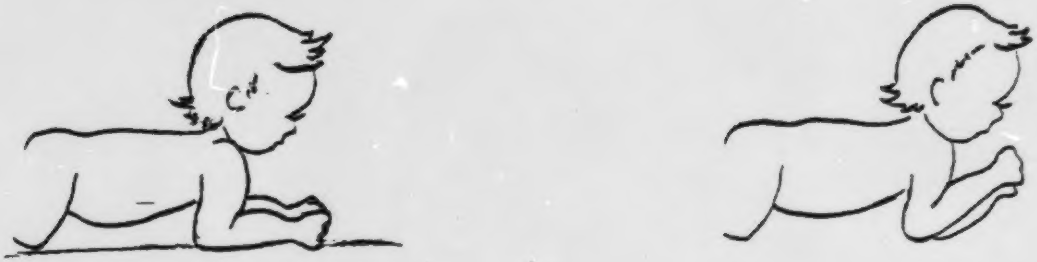
Abnormal tone. One or a combination of the following abnormal tones may be observed in a child. The tones usually seen together are internal rotation and extension of the arms with adduction of the hips and extension of the legs.

1. Extension is the straightening of any part of the body - limbs, neck or trunk. Hyperextension is straightening beyond neutral (see Figure 8a).
2. Internal rotation is a rotation of two points, i.e., both arms or both legs, which orient or turn toward the middle of the body. This is also referred to as inward rotation (see Figure 8a).
3. Adduction is movement of the extremities toward the midline of the body (see Figure 8b).

Leg positions for crawling:

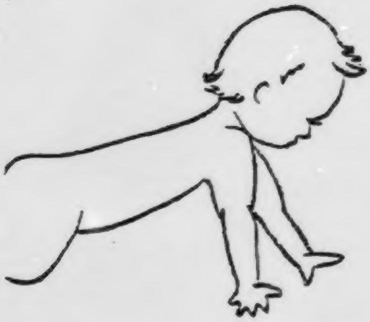
Leg flexed out - passive. The leg is touching the supporting surface and is bent at the knee at any angle. The bent leg is not observed to be used during the crawling (see Figure 9a).

Leg flexed out - active. The leg is touching the supporting surface



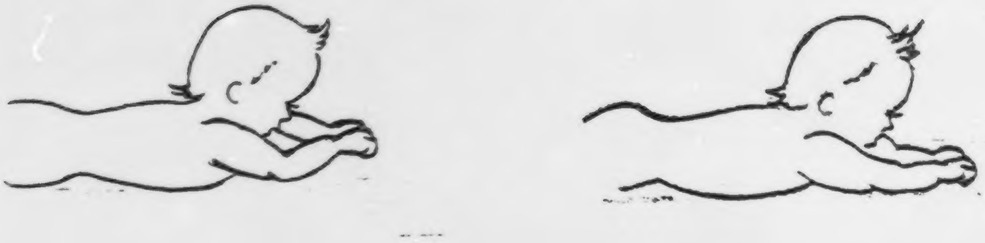
6a. Props on forearms.

6b. Props on elbows.



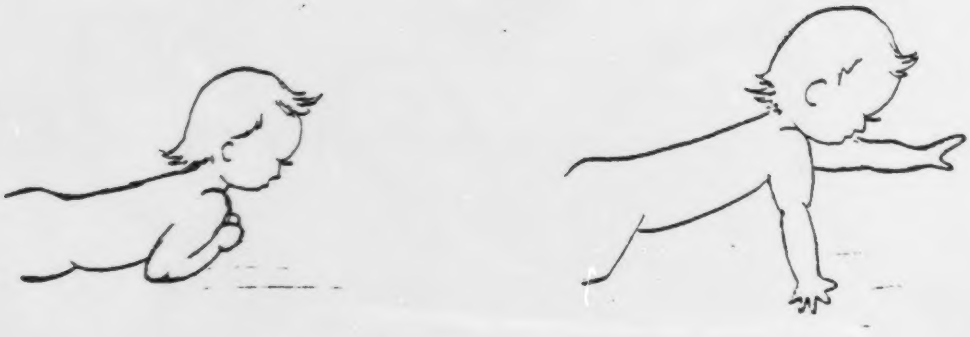
6c. Arm extended.

Figure 6. Illustrations of arm positions.



7a. The arm is bent to the side with any part of the upper arm touching the surface.

7b. The arm is straight out in any direction with the forearm touching the surface.



7c. The upper arm is touching the lower arm.

7d. The arm is in the air.

Figure 7. Illustrations of arms out of position.

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and is bent at the knee at any angle. The bent leg is observed to be used when the child crawls (see Figure 9b).

Leg extended - passive. The leg is straight with the lower part of the leg touching the supporting surface. The extended leg is observed to be used during crawling (see Figure 9c).

Leg extended - active. The leg is straight with the lower part of the leg touching the supporting surface. The extended leg is observed to be used during crawling (see Figure 9d).

Leg flexed - up. The upper leg is touching the supporting surface with the lower leg bent at the knee and not maintaining contact with the surface (see Figure 9e).

Leg positions for creeping:

Knee flexed down. The knee is bent so that the lower leg (from the knee to foot) is in contact with the support surface (see Figure 10a).

Knee flexed up. The knee is bent so that the sole or part of the sole of the foot is in contact with the floor (see Figure 10b).

Leg extended down. The knee is straight or slightly bent so that the sole or part of the sole of the foot is in contact with the floor (see Figure 10c).

No leg support. No part of the leg bears weight due to physical limitations such as paralysis.

Leg out of position (both crawling and creeping). Conditions warranting this code vary. They are:

1. In crawling, the legs are crossed, with both legs flexed up and only the upper leg in contact with the floor. The legs demonstrate normal muscle tone (see Figure 11a).
2. The upper leg is resting on the lower leg (see Figure 11b).

3. Child is sidelying, sidesitting, sitting up, supine, prone with head and chest on floor, or kneeling up.

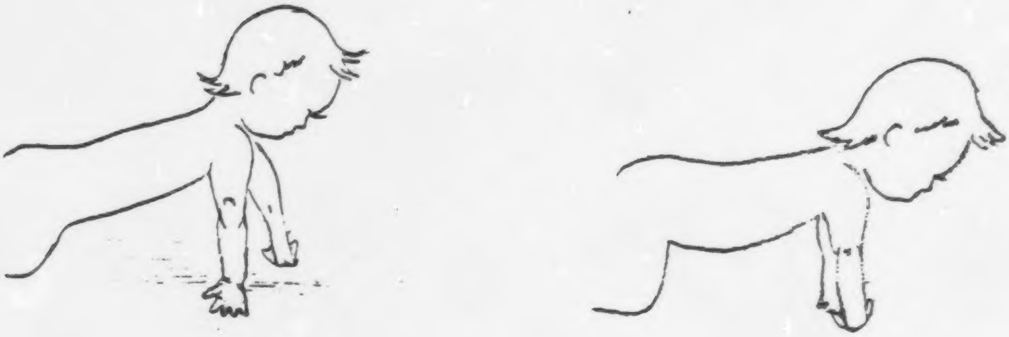
Abnormal tone (both crawling and creeping). One or a combination of the following abnormal tones may be observed in a child at one time.

1. Extension - refer to the section on abnormal tones under "Arm positions" (see Figure 12a).
2. Internal rotation - refer to the section on abnormal tones under "Arm positions" (see Figure 12b).
3. Adduction - refer to the section on abnormal tones under "Arm positions" (see Figure 12a and 12c).
4. Abduction is movement of the limbs away from the midline of the body (see Figure 12d).

Since crawling and creeping are being assessed together, the child may switch from the creeping position to the crawling position, but would not be coded as "out of position" if any of the crawling positions were being maintained.

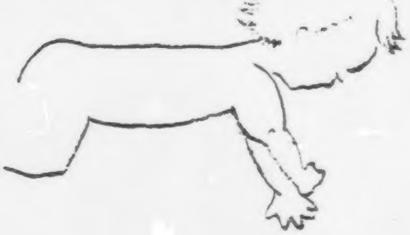
Recording crawling/creeping behavior. A ten second momentary time sampling procedure is used to record the position of the arms and the legs. At every ten seconds for one minute (six observations), the observer records the position of the child's limbs, adopting the code for positions. If the child demonstrates movement of locomotion in the position, the position of the arms and legs are still recorded.

The duration of maintenance in the position is found by adding up the total number of observations in which the child is in a crawling or creeping position and multiplying that number by ten for the ten second interval. For both crawling and creeping, at least three of the limbs must be coded in position in order for the observation to be included



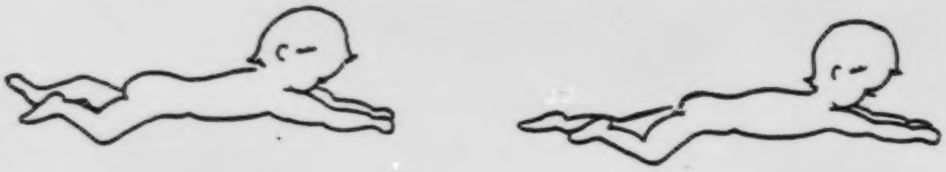
8a. Arms extended.

8b. Arms internally rotated.



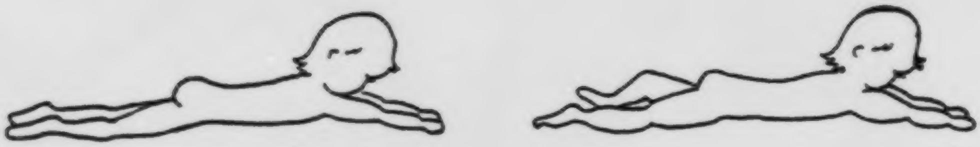
8c. Arms adducted.

Figure 8. Illustrations of abnormal tones for the arms.



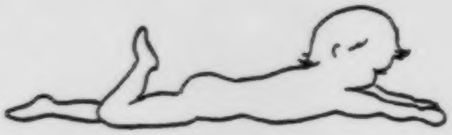
a. Leg flexed out - passive

b. Leg flexed out - active



c. Leg extended - passive

d. Leg extended - active

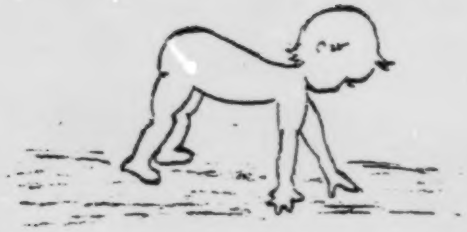


e. Leg flexed - up

Figure 9. Illustrations of leg positions for crawling.

9a. Knee flexed down.

9b. Knee flexed up.



9c. Leg extended down.

Figure 10. Illustrations of leg positions for creeping.

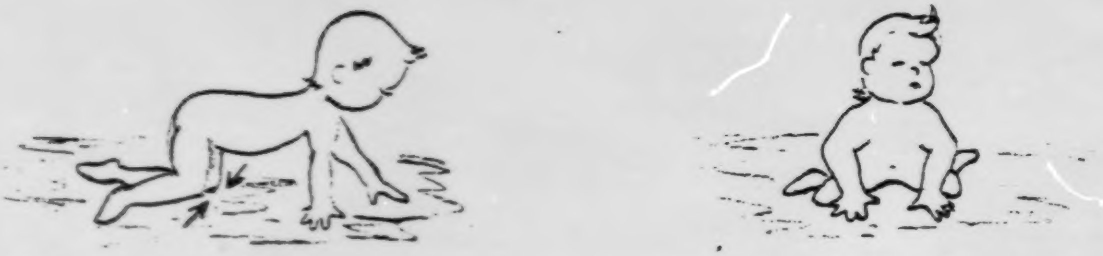
10a. The legs are crossed, with both legs flexed up and only the upper leg in contact with the floor.

10b. The upper leg is resting on the lower leg.

Figure 11. Illustrations of legs out of position.

11a. Legs extended and adducted.

11b. Legs internally rotated.



11c. Legs adducted.

11d. Legs abducted.

Figure 12. Illustrations of abnormal tones for the legs.

in the total duration time. The length of time the child maintains the position is an estimate based on the momentary time samples spaced apart by ten second intervals.

Beginning of trial. After the child has been placed in either the initial position (prone), the crawling, or the creeping position, the trial begins simultaneously with the presention of the cues. If the child needs cue 4, requiring the observer to place the child in position, the trial begins immediately after there is no physical contact with the child. The stimulus objects are then immediately activated.

Termination of trial. The length of the trial is one minute. During this time the trial may be temporarily stopped to reposition the child, but then the trial begins from where it left off until the one minute interval has elapsed. Another condition warranting a temporary stopping of the trial is when the child reaches the end of the mat or rug before the trial has ended. If this occurs, the tape is stopped, the child is given his toy or food for completing the distance, and is then turned around to complete the trial. This condition should be prevented if at all possible by finding an area that will enable the child to creep for a full one minute without stopping.

If the child should fail to maintain one position (either crawl or creep) and assume another position (either crawl or creep), the trial continues until one minute has ended.

Summary of assessment procedures for maintenance. The following is a brief outline of the process by which to administer these procedures:

1. Put the tabs labeled "L" and "R" halfway down the child's trunk on the appropriate sides.
2. Check the recorder and the stop watch to see if they are ready to

begin.

3. Place the object(s) or food three to five feet from the child.
4. Position the child either in the prone, crawling, or the creeping position with the hands on the tape.
5. Move in front of the child to simultaneously begin the tape recorder and cues.
6. Verbally or manually communicate throughout the trial for the child to move, as well as actively present the object, toy, or food the child likes.
7. Stop the recorder at the end of one minute (observation "6").
8. At the end of the trial, denote what cue(s) was/were used.
9. Determine the total length of maintenance.
10. At the end of three trials, complete the Assessment Administration Chart.

Specification for Taking Measures of Reliability

Reliability measures are taken from direct observation. The procedures for calculating reliability are as follows.

Leg and arm position recordings. Separate reliability scores are calculated for leg positions and for arm positions. The number of agreements and the number of disagreements between two observers for the child's leg positions can be totaled for each session across all trials. The number of agreements was divided by the number of agreements plus disagreements and multiplied by 100 to obtain the reliability percentage of each session. The formula is as follows:

$$\frac{\text{\# of agreement}}{\text{\# of agreement + disagreements}} \times 100$$

The mean reliability score for legs, across all sessions, is then determined by adding together all the reliability scores from each session and dividing by the total number of sessions. The same procedures are used for obtaining reliability scores for the arm positions.

Duration recordings. The reliability percentages for each session across all trials are determined by dividing the larger duration number into the smaller duration number and multiplying by 100. The average reliability score for the four sessions is obtained by adding together all the percentage scores from each session and dividing by the total number of sessions.

The mean reliability for all of the children across all sessions is calculated for leg positions, arm positions and duration. The scores for the leg positions from every session and from every child are added together and then divided by the total number of percentages. The same process can be applied in calculating the mean reliability for all children on all sessions for arm positions and duration.

The mean reliability score for each child across all sessions and all behaviors was also calculated. This was obtained by adding together all the sessions reliability scores for each behavior and dividing by the total number of scores from all four sessions.

Measuring Movement in the Crawling/Creeping Position

Specification of Behavior

The movements which are being scored for crawling and for creeping include rocking, pivoting and stepping. The measures taken for movement in these positions are frequency and duration.

Materials and Equipment

Basically, the same materials and equipment used for measuring maintenance in the position are suitable for measuring movement in the position. The mat or rug should be at least twelve to fifteen feet in length so that after the child is positioned on the rug or mat there is ten feet remaining, space enough for the child to move. Masking tape, measuring about three feet long is again needed for a starting point on the floor, placed a few feet from the edge of the rug or mat.

Stimuli may be needed to motivate the child to move and includes edibles, or stimulating visual, auditory, or tactile toys and objects. Selection of the consumable or maniputable items will depend on the individual child's interests and physical handicaps.

The tape recorder with the tape recording of the ten second intervals is again applicable for measuring movement responses. The numbers "1, 2, 3 . . . 12" are recorded on the tape spaced by ten second intervals totaling a two minute time period. For movement in the position measurements, however, the tape is stopped after the number six is announced, corresponding to sixty seconds, the length of the trial.

The data sheet labled "Movement in the Position" (see Figure 13a and 13b), the Assessment Administration Chart (see Figure 4), a pencil, and a stop watch are also needed.

Observational Settings

Observations for moving in the creeping position occurs in a structured setting, either in the homes of the children, in the classrooms or other school locations.

Conditions for Observing Movement

Procedures for the use of this data sheet are only implemented if movement in the crawling or creeping position is observed using the first data sheet. Movement includes pivoting, rocking, and stepping for crawling, and rocking and stepping for creeping.

Observation before actual measurement. To determine how to count movement in crawling and creeping, the observer may want to observe the child several times before scoring the data sheet. This may be possible at a time other than during actual assessment so that extra trials do not tire the student during the assessment. These observations enable the observer to get a better understanding of how the child moves, in terms of speed, consistency and type of movement. Through these observations, the observer may determine the most accurate way of counting and can prepare himself for counting steps by practicing several times.

There are two methods for counting steps. One may be chosen depending upon the movement and speed of the child. If the child is inconsistent in the pattern of movement (not moving the limbs the same way most of the time) and/or slow in his manner of moving the limbs, the most accurate way found is to count each limb singly as it moves. The second method of counting is applicable if the child is consistent and quick in moving any two limbs simultaneously (arms together and legs together or an arm and a leg and the other arm and leg). In this case, the observer may count the two limbs that move together as one and then double the total number of steps at the end of the trial, or the observer may count by two's. The speed with which a child moves is a factor in deciding on the method of counting. If the child is fairly quick, counting two limbs as one may be an alternate method and just as effective than singly counting each limb. However, if the child is slow in moving, each limb may be counted singly. This is the preferred method since sometimes a child may switch

CRAWLING AND CREEPING #2A
MOVEMENT IN THE POSITION

NAME________________ DATE____________ LOCATION____________

OBSERVER 1________________ OBSERVER 2____________ RELIABILITY____________

CUES

1 = OBJECT, TOY, FOOD
2 = DEMONSTRATION
3 = PROMPT
4 = PUT THROUGH

DIRECTION FOR CRAWLING STEPS

F = FORWARD
B = BACKWARD

$$\text{RATE} = \frac{\text{NUMBER OF MOVEMENTS}}{\text{TOTAL DURATION}}$$

TRIAL	CUE	TOTAL FREQUENCY OF MOVEMENTS												TOTAL MOVEMENT	TOTAL DURATION	TOTAL RATE	RELIABILITY
		CRAWLING						CREEPING									
		PIVOTS	RATE	ROCKS	RATE	STEPS	RATE	ROCKS	RATE	STEPS	RATE						
1																	
2																	
3																	
4																	
5																	
6																	

Figure 13. Data Sheet 2A , Movement in the Position.

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CRAWLING AND CREEPING #2B

CODE FOR OBSERVATIONS: O = OUT OF POSITION X = ABNORMAL TONE

TRIAL	OBSERVATIONS OUT OF POSITION OR ABNORMAL TONE	CRAWLING			CREEPING	
		PIVOTS	ROCKS	STEPS	ROCKS	STEPS
1	1 2 3 4 5 6					
2	1 2 3 4 5 6					
3	1 2 3 4 5 6					
4	1 2 3 4 5 6					
5	1 2 3 4 5 6					
6	1 2 3 4 5 6					

M(C)33

the pattern of movement. If the observer is counting two limbs together, it is difficult to switch from counting two limbs together to single counting.

To decide which method to employ before actually taking data, the observer may first try the single counting method for two trials, since this is the preferred method. If there is 80% agreement among observers, then the second method should not be considered. If 80% agreement is not reached, then the second method, counting by two's, can be tried. However, if 80% reliability is not obtained, then the first method should be used and practiced until 80% agreement is reached.

Initial positioning procedures. The initial positioning of the child is determined by the child's performance on the behaviors measured by the first data sheet. For example, if the child responds to one of the first three cues with a crawling or creeping response on the first data sheet, then the child is placed in the prone position with the arms out from under the trunk for the second data sheet. The hands are placed on either side of the head on the tape so that the tape is approximately in the middle of the hand (see Figure 4, Steps 1B, 3A or 3B, and 5; or Steps 1C and 7). Positioning the child in this manner occurs for three trials. If it was necessary to place the child in a crawling position using a put through during the measurement of maintenance on Data Sheet 1, then a put through cue 4, is employed for the measurement of behavior required on this data sheet for all six trials. The child is put into a crawling position for the first three trials and a creeping position (if the child maintained this position on the first data sheet) for the last three trials (see Figure 4, Steps 3B, 5A or 5B, and 9). However, if there was no crawling response to cue 4 on the first data sheet, then the behavior does not need to be assessed on the second data sheet (see Figure 4, Steps 1A, 2A, and 4). If the child creeped using cue 4, a put through, on the first data sheet, then cue 4 is used again on the second data sheet. The child is placed in a creeping position on hands and knees, with the hands centered on the tape (see Figure 4, Steps 1A, 2A or 2B, 4A or 4B). If there was no creeping response to cue 4 on the first data sheet, then it is not necessary to assess the behaviors on the second data sheet.

Finally, if the child responded to cue 1 (object, toy, food), cue 2 (demonstration), or cue 3 (prompt) by creeping as indicated on the maintenance data sheet, then these cues will be employed after placing the child prone on the floor with the hands in position as previously described (see Figure 4, Steps 1C and 7). It is possible that no further trials are needed after the first three, but if the child does not creep, the observer may then have to do the trial at a later time since motivation is a major factor influencing the child's behavior.

The procedures for describing positions and cues are rather long and cumbersome. Therefore it is strongly recommended to refer to the Assessment Administration Chart (see Figure 4) to more easily follow the sequential procedures for positioning and cueing the child for Data Sheet 2.

Positioning procedures. The child is positioned at the beginning of each trial, already defined and determined by the purpose(s) of the measurement and outlined in Figure 4. Repositioning may be necessary after three consecutive observations of the child demonstrating behaviors defined as "out of position" or "abnormal tone".

A "O" for "out of position" and an "X" for "abnormal tone" is marked on Data Sheet #2B (see Figure 13b) under the column "Observations: Out of Position or Abnormal Tone". Two or more limbs must be out of position or demonstrate abnormal tone in order to use this code. These codes are written over the number corresponding to the observation for that trial. For example, if the child has two or more limbs out of position when the tape says "2", then a mark is made on the "2" on the data sheet. The recorded code would appear as 2 .

Position of observer. The observer kneels or stands up directly in front, but a few feet ahead of the child so that all the child's limbs are visible.

Providing Cues to the Child

The four cues used for measuring maintenance in the position are also applicable for measurement of these behaviors. The manner of demonstrating and prompting is slightly different.

1. Object, toy, food. This includes any visually, auditorily, or tactiley stimulating object or toy that is reinforcing to the child. Any food or drink the child may like may serve as a stimulus. The item(s) selected is/are placed three to five feet from the child and are activated through the trial. If the child progresses forward toward the items(s), then the item(s) is/are placed further away until the one minute trial or ten feet is completed.
2. Demonstration. The observer gets into the crawling or creeping position, depending upon the behavior being assessed. The observer then rocks back and forth or locomotes, depending on the child's abilities. That is, if the child only rocks, then rocking is demonstrated, but if the child is capable of locomoting, then locomotion is demonstrated.

3. Prompt. The observer lightly lifts the child at the shoulders or hips no more than two inches off the ground. If the child has already gotten into the position, then the observer may lightly pat or push the child from behind in order to encourage the child to move.

4. Put through. The observer physically puts the child into a crawling or creeping position.

The cues used in this procedure to obtain a crawling or creeping response will be determined by the reactions of the child to the cues presented in the first data sheet. One or a combination of one of the first three cues are presented to obtain a creeping response if the child demonstrated this response when presented with one or a combination of one of these cues during measurement of behavior on the first data sheet. If a put through was needed for the child to maintain the creeping position, then cue 4, the put through, will again be used for this data sheet. Figure 4 illustrates what cues to give for each trial on the second data sheet.

Measuring Crawling and Creeping Movement

Description of Behavior. Three types of movement are identified for the crawling position. They are defined as follows: 1) a step is defined as one progressive movement forward or backwards of one limb; 2) a step-pivot is defined as lateral movement of one arm and resulting lateral movement of that shoulder and; 3) rocking is defined as a forward or backward movement of the limbs.

Creeping movement can either be rocking or stepping. Rocking is defined as the total cycle of one forward, backward and forward movement of the trunk with no progressive movement of the limbs. This must be demonstrated with three or four points of support remaining in contact with the surface. A step is defined as one progressive movement forward on one limb.

Recording crawling/creeping movement. The total number of movements in either the crawling or creeping position are counted for a one minute time period. or a distance of ten feet, whichever comes first. For creeping, the movements may be recorded on Data Sheet #2B (see Figure 13b). After the trial is completed, the tallies are added up and the total number of each type of movement is recorded in the appropriate columns. Then the total number of all movements for crawling and creeping is placed in the column labeled "Total Movements". The rate for each type of movement and all the movements combined is determined by dividing the time of the trial into the number of movements. The rate for each movement and the rate for all the movements combined is recorded under the "Total Rate" column.

The duration is either the amount of time the child requires to travel ten feet or, if the child does not locomote this distance, the entire sixty second time limit of the trial is recorded as the duration.

The minimum number of trials on the data sheet is three. This occurs if the child's response to one or a combination of the first three cues is creeping on the first data sheet. If the child does not creep but crawls using any one of the four cues, then the first three trials on the second sheet will measure crawling and the last three trials will assess creeping. Procedures for assessment administration are illustrated in Figure 4.

Beginning of trial. The stop watch and tape recorder are started as soon as the child has been positioned in either the prone position,

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the crawling or the creeping positions and there is no more physical contact between the observer and the child. Once the stop watch and tape recorder have begun, the objects, toys, or food are actively presented as well as the verbal or manual communication.

Termination of trial. The trial ends when the child has locomoted the distance of ten feet or at the termination of a one minute observation, whichever comes first.

Summary of assessment procedures for movement. The following is a brief outline of the process by which to administer these procedures:

1. Check the recorder and the stop watches to see if they are ready to begin.
2. Place the object(s) or food three to five feet from the child if necessary, or at the ten foot criterion mark.
3. Position the child (prone, crawling, or creeping) with the hands on the tape.
4. Simultaneously beging the stop watch and recorder and then immediately present the cues.
5. Verbally or manully communicate throughout the trial for the child to move, as well as actively present the object, toy, or food the child likes.
6. Stop the watch and the tape recorder if the child completed the designated distance OR stop both of them when the tape says "6", the end of the one minute interval.
7. Tally up the number of each type of movements as well as all movements together and record on Data Sheet #2A.
8. Calculate the rate of movment.
9. Record the cue(s) used and the duration of the trial.
10. At the end of three trials, complete the Assessment Administration Chart.

Specification for Taking Measures of Reliability

Movement recordings. Reliability percentages for each type of movement (pivots, rocks in crawling and rocks in creeping, steps in crawling and steps in creeping) are recorded separately. For each session across all trials, the number of agreements and the number of disagreements for each type of movement are tallied, using the following formula to determine reliability scores:

$$\frac{\#\text{ of agreements}}{\#\text{ of agreements + disagreements}} \times 100$$

Calculating the mean reliability scores across sessions for each movement consists of adding the reliability percentages for each movement and dividing by the total number of sessions.

Duration recordings. The reliability scores for duration of movement in each session can be determined by dividing the smaller duration number by the larger duration number and then multiplying that number by 100. By adding together the percentages from all the sessions and dividing by the total number of session, the mean reliability score across all sessions for each child can be obtained.

The mean reliability score for all subjects across all sessions is obtained by adding together all the percentages from all the sessions for every child and dividing that number by the total number of percentages from all the sessions of every child.

The mean reliability scores for each subject across all session and all behaviors are determined by adding together from all the sessions, the percentages for the various types of movements for both crawling and creeping as well as the reliability scores for duration. This number is then divided by the total number of percentages from all the sessions.

Measuring Locomotion in the Crawling/Creeping Position

Specification of Behavior

Measurement of locomotion, which is the actual stepping movements of the child, consists of recording the pattern or the order in which each of the various limbs move. The distance the child travels as well as the time it took to travel are also measured. Once these are established then the rate of movement is tabulated.

Materials and Equipment

A rug or mat, twelve to fifteen feet in length is employed for measurement of locomotion. The same one used for previous measurements may be utilized. For this procedure, masking tape, approximately three feet long is needed for a starting point as well as a stopping point. The first piece of tape is placed a few feet from the edge of the rug or mat and the second piece is applied ten feet from the starting point.

Similar objects, toys, or food used for the first two measurement procedures may be utilized, unless the child is no longer interested in them. Different foods or new motivational items that are also visually, auditorily or tactilely stimulating may be necessary in order to get the child to elicit a locomoting response. The child's interests and physical handicaps must be considered when selecting items.

Four cardboard circular tabs, 2½ inches in diameter and covered with contact paper are needed to record the pattern of movement. Each one is marked with either a "1", "2", "3", or "4". The circle labled "1" is placed on the child's left side in the shoulder area; "2" is in the right shoulder area; marker "3" is put on the child's left side in the back area; and "4" is placed in the lower back area on the right side (see Figure 14).

The tape recorder and tape with the ten second intervals are also necessary for these measurements. The tape has recorded on it the numbers "1, 2, 3 . . . 12", totaling a two minute time period. The full two minute recording is played for this procedure.

A stop watch, a tape measure or yard stick, making tape and the data sheet for "Locomotion in the Position" (see Figures 15a and 15b), the Assessment Administration Chart (see Figure 4), and a pencil are the other required items.

Observational Settings

Measurement for locomotion can occur in the homes of the children, in the classroom or other school locations. The observational settings are structured so that the main emphasis is measuring locomotion of the crawling or creeping behaviors.

Conditions for Observing Locomotion

If the child produces eight crawling or creeping steps per minute or .13 steps per second in any of the trials of the data sheet for Movement in the Position", then data should be taken on locomotion in the position. If the child met criterion for steps in both crawling and creeping on the second data sheet, then both behaviors need to be assessed.

Observation before actual measurement. To facilitate the recording of movement patterns, it is recommend that observation of the child occur several times before beginning the actual assessment process. This is to give the observer a basic idea of the child's pattern, rhythm, and speed of movement. Practice in recording numbers is especially necessary if the child moves quickly and consistently.

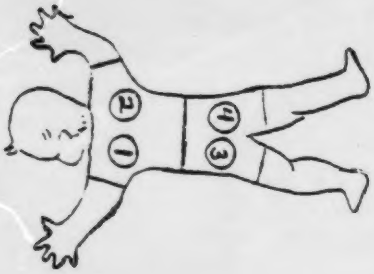
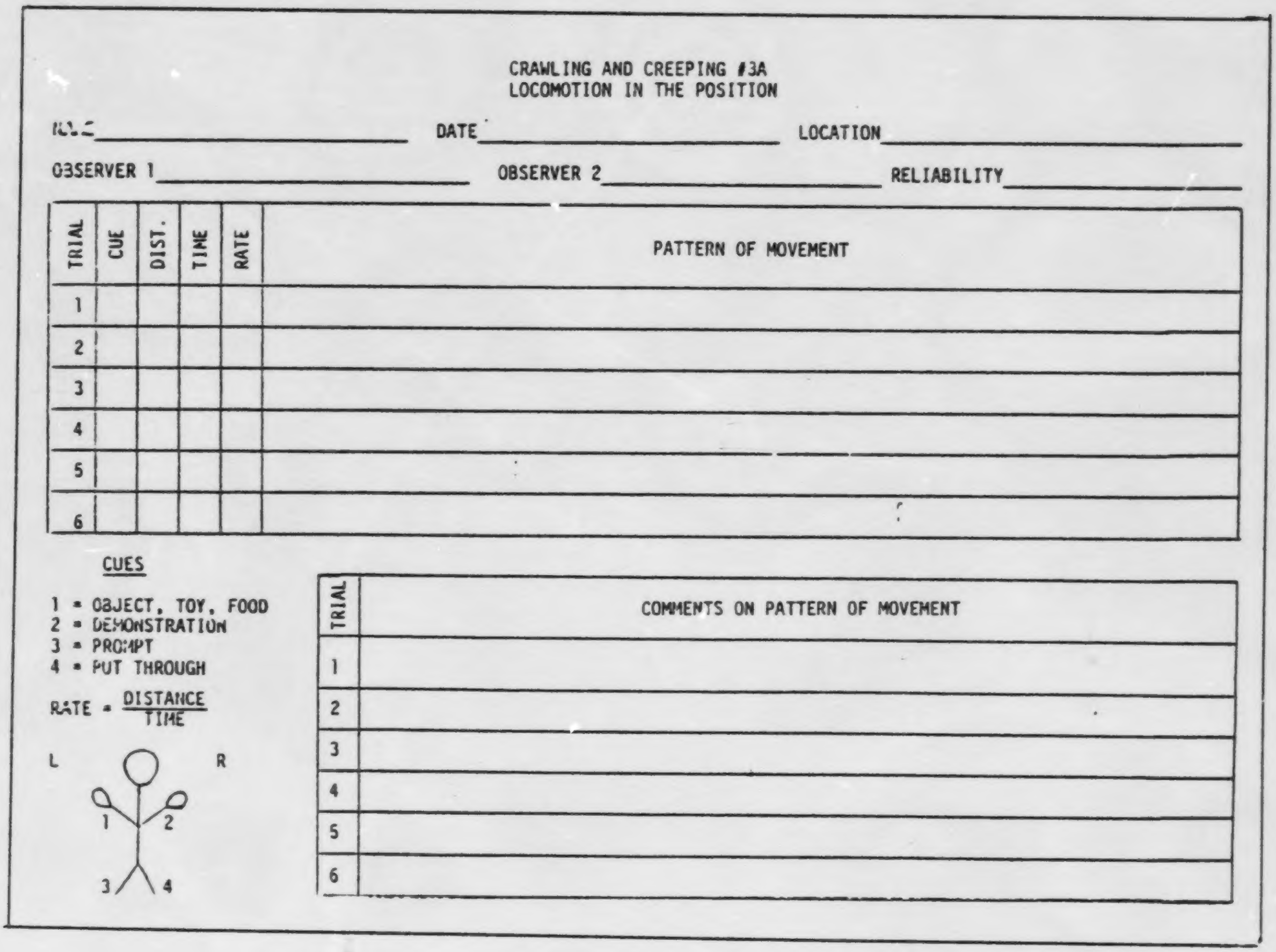


Figure 14. Placement of circular tabs for locomotion in the position.



CRAWLING AND CREEPING #3A
LOCOMOTION IN THE POSITION

NAME__________ DATE__________ LOCATION__________

OBSERVER 1__________ OBSERVER 2__________ RELIABILITY__________

TRIAL	CUE	DIST.	TIME	RATE	PATTERN OF MOVEMENT
1					
2					
3					
4					
5					
6					

CUES

1 = OBJECT, TOY, FOOD
2 = DEMONSTRATION
3 = PROMPT
4 = PUT THROUGH

RATE = $\frac{\text{DISTANCE}}{\text{TIME}}$

TRIAL	COMMENTS ON PATTERN OF MOVEMENT
1	
2	
3	
4	
5	
6	

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Figure 15. Data Sheet 3A , Locomotion in the Position.

CRAWLING AND CREEPING #3B

CODE FOR OBSERVATIONS: 0 = OUT OF POSITION X = ABNORMAL TONE

TRIAL	OBSERVATIONS OUT OF POSITION OR ABNORMAL TONE	PATTERN OF MOVEMENT
1	1 2 3 4 5 6 7 8 9 10 11 12	
2	1 2 3 4 5 6 7 8 9 10 11 12	
3	1 2 3 4 5 6 7 8 9 10 11 12	
4	1 2 3 4 5 6 7 8 9 10 11 12	
5	1 2 3 4 5 6 7 8 9 10 11 12	
6	1 2 3 4 5 6 7 8 9 10 11 12	

M(C)45

Initial positioning procedures. The initial position of the child is determined by the responses demonstrated during the recording of behaviors for the second data sheet. If the child only demonstrated six steps in crawling and less than eight in creeping, then only crawling would be assessed on the first three trials (see Figure 4, Steps 1B, 3B, 5B, and 9A). Similarly, if the child demonstrated eight steps in creeping and less than six steps in crawling, then creeping would be assessed. Whatever initial position was necessary for the second data sheet will also be used for the locomotion data sheet. For example, if the child obtained a creeping response after being placed prone and given the cues 1 (object, toy, or food), 2 (demonstration), or 3 (prompt), then the child will be put into the prone position for this procedure (see Figure 4, Steps 1C and 7). If cue 4, the put through, was needed, then cue 4 will be used for this data sheet (see Figure 4, Steps 3B, 5A or 5B, and 9). In either case, the child's hands are placed on top of the masking tape.

Positioning procedures. The child is positioned at the beginning of each trial, determined by the purpose of the measurement. Repositioning occurs after three consecutive observations of the child demonstrating behaviors defined as "out of position" or "abnormal tone" for two or more limbs. Repositioning refers to putting the child back into the initial position under observation.

The code and procedure used to denote "out of position" and "abnormal tone" are the same as for Data Sheet #2B, "Movement in the Position." Refer to the "positioning procedures" under the section labeled "Conditions for Observing Movement" in the measurements for movement in the position.

Position of observer. The observer is situated a few feet in front of the child. The most beneficial position is to kneel or stand up so that the numbers and all the limbs are easily visible.

Providing Cues to the Child

The same four cues employed for "Movement in the Position" can also be applied for attaining locomotion behavior. Refer to the section, "Provides Cues to the Child" in the procedures for measuring movement in the position.

The cues used to elicit either a crawling or creeping response are the same as for the procedures delineated in Data Sheet #2, which depended on how the child reacted to the cues in the first data sheet. If the child creeped in response to one of the first three cues, then these are used to obtain the behavior. However, if the child required a put through, cue 4, to demonstrate creeping, then the child will be positioned on all four limbs for this procedure. Again, refer to Figure 4 to further clarify what cues to use for each trial.

Measuring Crawling and Creeping Locomotion

Description of the behavior. Locomotion in the position is defined as the actual number of steps the child takes, defined as one progressive movement forward of one limb. The emphasis of this procedure is the pattern of locomotion or the order in which the child moves his limbs.

Type of measurement used. The pattern of movement is procured by recording the order in which the limbs moved. Each of the limbs are numbered on the child's body and these numbers are written down on Data Sheet #3B (see Figure 15b) when they move. If two limbs move simultaneously, the left side is coded first and then the right. When two limbs on the same side or opposite sides locomote together, then the arm number precedes the leg number. These types of movements should then be specified in the "Comment" section on Data Sheet #3A (see Figure 15a), describing what limbs moved simultaneously or consecutively and whether the pattern was fairly consistent or inconsistent.

When recording the pattern, Data Sheet #3B is employed first. This information is then transferred onto Data Sheet #3A. The distance the child traveled is also registered on Data Sheet #3A. In order to measure the distance traversed, the observer records from the starting point to the approximate point where the movement of the heel of the hand ceased.

The time needed to travel the distance of ten feet is recorded on the data sheet. However, if the child does not travel ten feet, then two minutes (the total length of the trial) is recorded in the time column. After the distance traveled and duration have been determined, then the rate of locomotion is calculated by dividing the distance traveled by the time.

The minimum number of trials on the data sheet is three. This occurs if the child meets the minimum criterion for the number of steps in crawling or creeping, eight steps per minute or .13 steps per second. This is determined by the behaviors measured via the second data sheet on movement. If the child is locomoting in both positions, then six trials are required, the first three in crawling and the last three in creeping.

Beginning of trial. After the child has been positioned either in prone, crawling, or creeping, depending on the cues being used, measurement commences with the presentation of preferred objects, toys, or food and the verbal or manual communication. The stop watch and tape recorder begin at the same time also. If the child requires placement in the position, the recorder and stop watch begin when the observer no longer has physical contact with the child.

End of trial. The end of the trial is determined when the child travels the distance of ten feet or at the expiration of two minutes, whichever comes first.

Summary of assessment procedures for locomotion. The following is a brief outline of the process by which to administer these procedures:

1. Arrange the tabs marked "1", "2", "3", and "4" on the appropriate places on the child's back.
2. Check the tape recorder and the stop watches to see if they are ready to begin.
3. Place the object(s) or food three to five feet from the child if necessary or at the ten foot criterion mark.
4. Position the child (prone, crawling, or creeping) with the hands on the tape.
5. Simultaneously begin the stop watch and recorder and then immediately present cues.
6. Verbally or manually communicate throughout the trial for the child to move, as well as actively present the object, toy, or food the child likes.
7. Stop the stop watch and tape recorder if the child completes the designated distance OR stop both of them at the end of two minutes.
8. Observe and mark the placement of the child's hands and measure the distance traveled if the ten foot criterion was not met.
9. Denote what cue(s) was/were used, the distance traveled and the time on the data sheet.
10. Calculate the rate of movement.

11. Transfer the pattern of movement from Data Sheet #3B to Data Sheet #3A.

12. Comment on the manner of pattern of movement, specifiying whether the limbs moved simultaneously or consecutively.

13. At the end of three trials, complete the Assessment Administration Chart.

Specification for Taking Measures of Reliability

Pattern recordings. The number of agreements and the number of disagreements is recorded for each session. Agreements and disagreements are determined by comparing Observer 1's data against Observer 2's data using a sliding criterion method. If the number in the pattern matches, they are considered agreements, but if Observer 2 has different numbers, not enough numbers, or too many numbers when compared to Observer 1, then these are counted as disagreements. If Observer 2 did not have enough numbers or too many numbers, then the pattern of Observer 2 "slide" up or back in order to better match Observer 1's data. The following example illustrates this method. The "+" above the numbers denotes agreements, while the "-" signifies disagreements:

Observer 1's Data: 3-4-3-4-2-3-1-4-2-3-2-3-2-3-1-4-2
Observer 2's Data: 4-3-4-2-3-1-4-2-3-2-3 1-4

Observer 2's data will "slide up" one number since observer 2 is missing the first "3" as follows:

Observer 1's Data: 3-4-3-4-2-3-1-4-2-3-2-3 A 2-3-1-4-2
Observer 2's Data: 4-3-4-2-3-1-4-2-3-2-3- 1-4

The pattern only matches up to point A. After point A, there is a disagreement in the numbers. Observer 2's pattern may then slide back so that the "1-4" matches:

```
                       - + + + + + + + + + + + - - + + -
Observer 1's Data:     3-4-3-4-2-3-1-4-2-3-2-3-2-3-1-4-2
Observer 2's Data:       4-3-4-2-3-1-4-2-3-2-3     1-4
```

Therefore, the total number of agreements would be 13 and the total disagreements would be three. However, if this were the beginning and end of a trial, the first "3" and the last "2" would not be considered disagreements since three or fewer numbers at the beginning or end of a trial may be deleted since both Observer's may not begin to record at the same time.

The total number of agreements is divided by the total number of agreements plus disagreements and multiplied by 100 to obtain the reliability score for each session across trials. The mean reliability percentage for all sessions is obtained by adding together the percentage scores from session and dividing by the total number of sessions.

Percentage scores from each session for both subjects is added together and divided by the total number of sessions to obtain the average reliability percentage for all sessions and for both subjects.

MOBILITY

Procedures for Measuring Standing and Walking

By

Melinda Shepard

and

Donna Lehr

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[1] The procedures reported in this study were taken, in part from a master's thesis conducted by Melinda Shepard that was submitted to the Department of Special Education at the University of Kansas in 1980.

Selecting the Target Behviors

The development of standing and walking is considered to be one of the most important behaviors in terms of independence of functioning in our society. For most this development occurs without any difficulty however each time we observe a child's first steps we marvel at the observed miracle! For children with severe and multiple handicaps the development of walking is a often a long and difficult process. Development of the necessary skills is often slow in emergence and change or progress is often very slow. For these reasons it is necessary to have available assessment procedures sensitive enough to detect the small changes in skills to assist the teacher or therapist in determining the current level of skill of the child and to evaluate the effectiveness of intervention strategies used.

As a consequence of reviewing standardized and nonstandardized assessment instruments and research related to the development of mobility skills, distinct behaviors related to the development of standing and walking were identified and operationally defined. Specific procedures were then developed to measure those behaviors. The categories of behaviors include pulling to stand, standing and cruising, and walking with various degrees of independence.

Developing the Measurement and Observation Procedures

Each of the categories of skills, pull to stand, standing and walking is discussed in relationship to seven areas: (a) Specification of the Behavior; (b) Materials and Equipment; (c) Observational Settings;

(d) Conditions for Observing; (e) Providing Cues to the Child; (f) Measuring Standing or Walking Behaviors; and (g) Specification for Taking Measures of Reliability.

Measuring Pull to Stand Behaviors

The behaviors under consideration in this section are those related to the attainment of a standing position by a child seated on the floor. Measures are recorded of the leg movements used in attaining the position as well as the length of time required to complete the process. This behavior is measured under several conditions including pulling to stand with the assistance of a table, bar or rail or a crib side.

Materials and Equipment

The materials required in the use of these measurement procedures include the data sheet entitled "Pull to Stand" (see Figure 1), a stop watch and a pencil.

Three different types of equipment are needed to measure the conditions under which standing can occur. These include a table, a bar attached to a wall and a crib side. The table needs to be at the most, two inches higher than the child's shoulder when the child is sitting on the floor. A table with adjustable legs is recommended enabling adjustments for specific heights to match the children involved in the assessment. The bar used may be either a railing attached to the wall or the rung of a ladder. This also should be positioned no higher than two inches above the shoulder of the child. The crib side used may be the complete crib, if available, or just the side of a crib attached to a wall. This may be positioned such that the botton edge of the side is close to the floor as would be the case in the child's crib.

A variety of toys and objects both edible and manipulable may be used

STUDENT ______________________________ DATE ______________________

CONDITION: Pulling to Stand

OBSERVER ______________________

2nd OBSERVER ______________________

RELIABILITY ______________________

TRIAL	CRIB	BAR	TABLE
SUMMARY			

CODE:
- H- Pulls to stand using half kneel position, within 30 seconds
- E- Pulls to stand using extended leg position, within 30 seconds
- O- Does not pull to stand

Figure 1. Pull to Stand Data Sheet.

to encourage the child to demonstrate the desired behaviors. The selection of these materials can be facilitated by questioning the child's parents or careproviders to determine "favorites" of each child. If this information is not available it is recommended that the teacher try a range of items to determine the preferred ones.

Observational Settings

Observations for measuring the behavior of pulling to stand can take place in a structured setting specifically designed to assess this skill or in an unstructured setting. In the latter case the child may be observed at play or in the course of his daily activities.

Conditions for Observing

Initial positioning procedures. The child should be placed approximately one foot from the equipment used in the assessment, i.e., crib, bar, table. Any position such as the creeping position, tall kneeling or sitting is acceptable. The child's hand(s) should be placed on the equipment used. When using the crib, the child's hands should be placed slightly higher then the child's soulders.

Repositioning procedures. The child is repositioned if after positioning the child, he turns away from the equipment either prior to the beginning of the trial or after the beginning of the trial and before standing.

Clothing considerations. The child's clothing should be such that body positions can be easily observed. Shorts or close fitting clothes are recommended. Shoes should be worn if they aid in the child's attainment of the position or if they are specifically prescribed.

Position of the observer. It is recommended that the observer be positioned behind the equipment, if possible, or to the side of it. He should position himself in a manner which assures observation of the legs for the duration of the observation period.

Specification for Cueing the Child

Physical cues. Physical cues which may be used include placing the child's hands on the equipment. The child's hands should be placed on the table, bar or in the case of the crib, the hands should be placed slightly higher than the child's shoulders. In the instance of limited use of one of the child's arms, the preferred arm should be used.

Object and verbal cues. Object and verbal cues can be used to encourage the child to pull to a standing position. It is recommended that the child be encouraged initially to stand by just positioning him in front of the equipment. In the event that he does not demonstrate the desired behavior, verbal directions can be given appropriate to the child's level of functioning or method of communication. If the desired behavior is not demonstrated toys or edibles may be used. The child can be provided with an opportunity to play with the toy or given the food contingent upon standing.

Specification of the Measurement System.

Description of the behavior. The behavior of pulling to stand includes the child raising from a position of sitting on the floor to a position in which the child's legs are at least supporting some weight while using a rail, bar or table to assist in the process. The measurement procedures are designed to assess the way in which the child attains the position as well as the time required to complete the task.

Specific descriptions of behavior observed are as follows:

Half-kneel. One foot is flat on the floor with the calf of the same leg vertical to the floor. The other leg has the knee resting on the floor along with the calf, the thigh is vertical to the floor.

Extended legs. Both the legs are extended behind the child with slight flexion in the knees.

Recording the behavior. The behavior of pulling to stand is measured by recording the attainment or nonattainment of the standing position within a specified amount of time (thirty seconds) and the recording of the method used by the child. These behaviors are assessed in each of the conditions of use of a table, railing and or crib side. (The conditions of the assessment are coded directly on the Data Sheet 1, Figure 1).

Beginning the trial. After the child has been placed in front of the equipment, the trial begins upon the presentation of the cues and the placement of the child's hands on the equipment. The stop watch should be activated at this point.

Termination of the trial. The length of the trial is thirty seconds. During this time the trial may be stopped if the child moves away from the equipment. Should the child begin to pull to stand and then return to sitting the trial should continue until the end of the thirty second period. If the child pulls to stand in significantly less than thirty seconds the trials still should be recorded as thirty seconds in length.

Trial sequence. At least three trials should be given to the child on each of the three types of equipment. Additional trials should be given at other times if it appears the child's performance was greatly attested by his level of motivation.

Specification for Taking Measures of Reliability

Reliability measures are taken directly from observations of children. Reliability measures are computed by using the following formula:

$$\frac{\text{\# of agreements}}{\text{\# of aggreements + disagreements}} \quad \text{X } 100$$

This represents the number of agreements divided by the number of agreements plus the number of disagreements multiplied 100. The reliability scores for each trial can then be added together and divided by the total number of trials to obtain the average (mean) reliability score for each session. This procedure can be repeated for each observational condition.

Measuring Standing and Cruising Behaviors

Specification of Behavior

The behaviors under consideration in this section are those related to standing, both assisted and independent. Measures are obtained including the child's base of support while standing, the positions of the child's legs while standing, and movement such as stepping and bouncing demonstrated by the child while standing.

Materials and Equipment

The materials required in the use of these measurement procedures include the data sheet entitlted "Standing and Cruising" (see Figure 2), a stop watch and a pencil and a sheet of paper approximately 18x18. A tape and tape recorder used to cue the observer to record specific behaviors is also necessary. The tape should have recorded on it a tone or bell occuring every twenty seconds for a total of two minutes.

Student____________

Condition: Standing
___ At Table
___ 2 Hands Held
___ 1 Hand Held
___ Unassisted

Date_________________

Observer_____________

Second Observer_________

Reliability_____________

		Frequency		Support at Table		Knee Positions	
Trial	Duration	Bouncing	Stepping	Hands	Arms	Flexed	Hyperextended
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
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		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					
		1 2 3 4 5 6					

Figure 2. Standing and cruising data sheet.

A table with adjustable legs is recommended enabling adjustments for specific heights to match the children involved in the assessment. The table should be adjusted such that is elbow height of the individual child when he is standing.

A variety of toys and objects, both edible and manipulable may be used to encourage the child to demonstrate the desired behaviors. The selection of these materials can be facilitated by questioning the child's parents or careproviders to determine "favorites" for each child. If this information is not available it is recommended that the teacher try a range of items to determine the preferred ones.

Observational Settings

Observations for measuring the behavior of standing can take place in a structured setting specifically designed to assess this skill or in an unstructured setting. The child in the latter case can be observed a play or in the course of his daily activities.

Conditions for Observing

Initial position. Standing is assessed under the conditions of standing at a table, standing while holding one to two hands of an adult and standing independently. To assess standing at the table, the child can either be allowed to assume standing position independently or should be placed in a standing position with his hands on the table. Support should be provided to the child until the child appears steady in that position. To assess standing with one or two hand supports the positioning differs only slightly after attaining the standing position independently or with assistance the child should be permitted to stand holding on to either one or both of the observer's hands. The observer's hands should be at a height enabling the child's forearms to be parallell with the floor. To assess independent standing, the child should either be permitted to assume the standing position independently or if it is necessary, the observer should place the child in an upright position, continuing support until the child gains his balance.

Repositioning procedures The child is repositioned if, after being positioned, he falls to the floor, fails to stand at least two seconds or assumes a squatting position.

Clothing considerations. The child's clothing should be such that body positions can be easily observed. Shorts or close fitting clothes are recommended. Shoes should be worn if they aide in the child's maintenance of the position or if they are specifically prescribed.

Position of the observer. It is recommended that the observer stand to the side of the child when measuring standing at the table. For assisted or independent standing, the prefered position is that of directly in front of or behind the child.

Specification for Cueing the Child

Object and verbal cues. Object and verbal cues can be used to encourage the child to maintain a standing position. It is recommended that initially the child be encouraged through the use of verbal, gestural or signed cues. If the child has not demonstrated the desired behavior, toys or edibles may be used and provided to the child contingent upon the child's demonstration of standing.

Specification of the Measurement System

Description of the behavior. The behavior of standing includes the child maintaining an erect position either with or without the assistance of an adult or with the support of a table. The measurement procedures are designed to result in the assessment of: 1) the position of the lower extremities while standing in terms of both degrees of flexion or extension and the width of the child's base of support; 2) movement such as bouncing and stepping demonstrated in this position; and 3) the duration of standing.

Specific description of behavior observed are as follows:

Bouncing. Rapid flexing and extending of the knees without the foot leaving the surface of support. One bounce is defined as the cycle of flexing and extending of the knee back to its original position.

Stepping-sideways. The raising of the entire foot from the surface and its replacement two inches or more to the side of the original placement.

Stepping - up and down. The raising of the entire foot from the surface and the replacement of it less than two inches from the original placement.

Lower extremities - flexed. The bending of the legs at the knee such that they protrace in front of a hypothetical line between the hip and ankle.

Lower extremities - hyper-extended. The "locking" of the knees such that they are positioned behind a hypothetical line between the hip and ankle.

Recording the behavior. The behaviors associated with standing are measured by recording the stance of the child while standing, the position of the child's lower extremities (flexed or hyper-extended), the duration of standing, and the frequency of movement demonstrated. These behaviors are recorded as the child stands with the support of a table, with one or two adult hands, or independently. (Each of these conditions are coded directly on Data Sheet 2, Figure 2.)

Measurement of the child's stance should be taken for each of the four conditions of standing which are assessed. This should be accomplished by positioning the child as described in the "Conditions for Observing" section on a large sheet of paper. A tracing should then be made of the places where the feet touched the paper. It is recommended that this tracing occur prior to the beginning of the assessment process for the other behaviors associated with standing.

The stepping behaviors described, both sidestepping and up and down stepping are recorded on the data sheet as a slash mark (/) each time the behavior is observed. Bouncing behaviors are recorded using a partial interval time sampling procedure. Using the tape recorder cues, the observer records every 20 seconds the occurance of any bouncing behavior in the previous interval as a slash (/) for that interval.

The duration of standing is recorded using a stopwatch. The watch is begun and stopped as specified in "Beginning of trial" and "Termination of Trial" sections.

The position of the child's limbs should be recorded as soon as the trial begins.

Beginning of the Trial. For each of the conditions of standing the trials should begin after the child has been placed in the position or assumes it himself and the child indicates that he has gained his balance.

Once the child has gained control, the stopwatch and tape recorder should be begun.

Termination of the Trial. Each trial ends either at the end of two minutes or when the child falls to the floor, stoops, or if at the table, when the child's head becomes level or lower than that of the table. The stopwatch should be turned off immediately upon observing these behaviors.

Trial Sequence

If the teacher is unfamiliar with the child being assessed and has had no opportunity to observed the child's standing behavior prior to the assessment it is recommended that the assessment begin with standing under the conditions believed to provide the most support to the child: standing at a table. The assessment should then procede to the assessment of standing with two hand support, one hand support and then independent standing. If the teacher has had the opportunity to observed the child in standing, the teacher or therapist may use his judgement regarding an appropriate starting place.

At least three trials should be given to the child on each of the conditions of standing which are considered to be appropriate. Additional trials should be given at other times as it appears that the child's performance is affected by his motivation at the time of the assessment.

Specifications for Taking Measures of Reliability

Reliability measures are taken directly from observations of children. Reliability measures for duration are determined by dividing the smaller duration measured by the two observers by the larger duration. That figure is then multiplied by the 100. Reliability scores for each trial can then be added together and divded by the total number of trials to determine the mean reliability for the session.

Reliability measures for bouncing behaviors can be computed by using the following formula:

$$\frac{\#\text{ of agreements}}{\#\text{ of agreements + disagreements}}\ \text{X } 100$$

The reliability scores for each trial can then be added together and divided by the total number of trials for the mean reliability for the session.

Reliability for stepping, sideways and up and down, is determined by dividing the smaller number of steps recorded by one observer, by the large number of steps observer for each trial. The relability score for the session can be summarized by adding each trials score together and dividing by the total number of trials.

The distance travled is measured by marking the location of the point at which the child either falls or has traveled 15 steps.

The distance traveled is measured by measuring the distance between the point at which the child began walking and the point at which he either falls or has travled 15 steps. Masking tape issued to make these points and a yard stick or tape measure is used to do the actual measuring.

The duration of time spent by the child walking is measured by the use of acumulative stopwatch. The begining and end points of this measure is specified in the sections entitled Beginning the Trial and Termination of the Trial.

Two summary scores can be calculated from the data obtained. The rate of steps taken while walking can be determined by dividing the number of steps taken by the number of seconds the child walked. This results in the number of steps taken per second.

The child's average stride length can be calculated by dividing the total distance traveled by the child by the total number of steps the child was observed to take.

Measuring Walking Behaviors

Specification of Behavior.

The behaviors under consideration in this section are those related to walking. Walking can be measured as the individual walks independently or with assistance. The specific aspects of the walking behavior which are recorded include the number of steps taken by an individual, the distance traveled in walking and the amount of time to travel a particular distance.

Materials and Equipment

The materials required in the use of these measurement procedures include the data sheet entitled "Walking" (see Figure 3); a stopwatch; a measuring tape; a strip of masking tape; and a pencil.

A variety of toys and objects, both edible and manipulable may be used to encourage the child to demonstrate the desired behaviors. The selection of these materials can be facilitated by questioning the child's parents or careproviders to determine "favorites" of each child. If this information is not available, it is recommended that the teacher try a range of items to determine the preferred ones.

Observational Settings

Observations for measuring the behavior of walking can take place in a structured setting specifically designed to assess this skill. An area free of obstacles is required. The area should measure at least

STUDENT ______________________________ DATE ________________

CONDITIONS: Walking
_____ 2 hands held
_____ 1 hand held
_____ Independent

OBSERVER ________________
2nd OBSERVER ________________
RELIABILITY ________________

TRIAL	STEPS	DISTANCE	TIME	AVERAGE STRIDE LENGTH	WRIST POSITION
SUMMARY					

CODE: Wrist Position

1. Wrist above ears
2. Wristen between ears and shoulders
3. Wrist between shoulders and waist
4. Wrist between waist and knees

Figure 3. Walking data sheet.

10 feet long and five feet wide and should have a hard surface or low pile carpeting.

Conditions for Observing

Initial positioning procedures. For the assessment of assisted walking the child should be permitted to assume a standing position or be placed in standing. The trainer should provide support to the child by extending his hands to the child, permitting the child to grasp the trainer's hands. while the child's hands remain parallel to the floor.

For independent walking, the child should be permitted to assume a standing position or be placed in standing. Once the child assumes his balance, any support which may have been provided to the child should be removed.

Repositioning procedures. The child is repositioned if, after positioning the child, he falls to the floor or assumes a squatting position. The repositioning can occur by providing either picking up the child or by offering a hand to the child for assistance.

Clothing considerations. The child's clothing should be such that the body positions can be easily observed. Shorts or close fitting clothes are recommended. Shoes should be worn if they aid in the child's walking or if the are specifically prescribed.

Position of the Obersver. It is recommended that the observer be positioned directly behind or directly in front of the child.

Specification for Cueing the Child.

Object and verbal cues. Object and verbal cues can be used to encourage the child to maintain a standing position. It is recommended that initially the child be encouraged through the use of verbal, gestural or signed cues. If the child does not demonstrate the desired behavior, toys and edibles may be used and provided the child contingent upon the child's demonstration of walking behavior.

Specification of the Measurement System

Description of the Behavior. The behavior of walking includes the child demonstrating stepping in a forward direction either with or without the assistance of an adult. The measurement procedures were designed to measure the number of steps taken by a child, the distance which the child walks and the amount of time the child requires to travel a particular distance. Also recorded is the position of the child's wrists in relationship to the rest of his body.

Specific descriptions of the behavior observed are as follows:

Step. The raising of the entire foot from the surface and its replacement two inches or more from the original placement.

Wrist- above ear. The child's wrist is held above the top of his ear.

Wrist-ear. The child's wrist is held between the top of his ear and the top of his shoulder.

Wrist-trunk. The child's wrists are held between the top of his shoulders and his waist.

Wrist-legs. The child wrist is held between his waist and knees.

Recording the Behavior. The behaviors associated with walking are measured be recording the frequency of steps taken, the duration of time it takes a child to travel ten feet and the location of each of the child's wrists as the beginning of a trial. These behaviors are recorded under the conditions of assisted walking and independent walking.

After the child has been correctly positioned and the trial begin the observer can begin to count the number of steps that the child takes.

Counting can be accomplished either by the observer counting the steps throughout the trial and recording the total number at the end of the trial of the observer recording hatch marks for each observed step during the course of the trial.

Beginning the trial. For each of the conditions of walking, the trial should begin after the child has either been placed in a standing position or assumed the position himself and the child indicates that he has gained his balalnce. The child should be positioned with his toes on a strip of masking tape placed on the floor serving as a starting point marker. Once the child has gained his balance it is at the starting point the stop watch should be begun and the measures initiated.

Terminiation of the trial. The trial is terminated upon the existance of any one of the following three conditions: 1) the child has taken fifteen steps; 2) the child has traveled a distance of 10 feet; or 30 the child falls or assumes a squatting position and does not recover to an upright position within five seconds.

Specifications for Taking Measures of Reliability

Reliability measures were taken directly from observations of children. Reliability measures of the number of steps taken were computed by dividing the smaller number of steps obtained by an observer by the larger number of steps observed. That number is then multiplied by 100. Reliability scores for each trial can then be added together and divided by the total number of trials to determine the mean reliability for the session.

Reliablity measures for the duration of walking was determined similarily. The shorter amount of observed time was divided by the longer amount of observed time. That number is then multiplied by 100 to gain the reliability score for that trial. The reliability scores for all the trials can then be added together and divided by the total number of trials for the mean relability score for the session.